South African Journal of Animal Science 2022, 52 (No. 5)

Behaviour of farmed fallow deer fawns in the rearing period depends on weather conditions

K. Tajchman[1#], Ż. Steiner-Bogdaszewska[2], P. Janiszewski[3]

[1]Department of Animal Ethology and Wildlife Management, Faculty of Animal Sciences and Bioeconomy, University of Life Sciences in Lublin, Akademicka 13, 20-950 Lublin, Poland

[2]Institute of Parasitology of the Polish Academy of Sciences, Research Station in Kosewo Górne, 11-700 Mrągowo, Poland

[3]Department of Fur-bearing Animal Breeding and Game Management, University of Warmia and Mazury in Olsztyn, Oczapowskiego 2, 10-719 Olsztyn, Poland

(Submitted 20 February 2022; Accepted 8 May 2022; Published 28 January 2023)

Abstract

Farmed fallow deer (*Dama dama*) fawns need to receive care and help from their mothers and be stimulated by other individuals, including their peers. This helps them to learn to live in a group, establish their place in the herd, acquire food, perceive dangers, survive, and initiate reproductive behavior. Adequate analysis of changes in behaviour conducted by deer breeders can be helpful in management of the animals. Furthermore, the knowledge of the time when any disturbance in the natural behaviour of animals should be avoided may contribute to improvement of their welfare. The aim of the research was to analyse the behaviour of fawns in the early rearing period and the influence of weather conditions. The observations were conducted in July 2017 and 2018. The fawns most frequently performed the observed activities in the morning and evening. The ritual playing and suckling bouts were most often noted in the evening. With an increase in air temperature and a decrease in humidity, the young fallow deer followed the doe and vocalized to call the mother, probably to persuade her to hide in a shaded place. A higher frequency of suckling was noted at an increased air temperature and humidity, but the suckling time was reduced with the increasing air temperature. A greater wind speed was associated with a higher frequency of allosuckling. The study showed that the natural behaviour of fawns, which has an impact on their functioning in the herd, should not be disturbed in the morning and evening.

Keywords: *Dama dama,* allosuckling, maternal nurse
[#]Corresponding author: katarzyna.tajchman@up.lublin.pl

Introduction

The mating season, pregnancy, and offspring rearing are some of the many aspects that distinguish one animal species from another. A common trait is the changes that species undergo from the conception through birth to maturity. These changes occur at different times and affect not only the anatomy or physiology of the animal. One of the most interesting and perceptible changes are those related to behaviour. From the moment of birth to reaching maturity and establishing their position in the herd, young animals of many species play, learn how to survive, and explore their environment and prevailing rules. This is the case of the European fallow deer. Fawns need maternal care and help as well as stimulation from other individuals, including peers. This helps them to learn to live in a group, establish their place in the herd, acquire food, perceive dangers, survive, and initiate reproductive behaviour (Burghardt, 2005, 2011; Carter *et al*., 2019).

When fallow deer are born, they are very lively and can quickly hide in bushes; therefore, they are rarely observed by people in nature. The few experiments that have been carried out have dealt primarily with the social behaviour of farmed deer (Krzywiński *et al.*, 1984; Gilbert, 1964). Farmed deer are classified as farm

URL: http://www.sasas.co.za
ISSN 0375-1589 (print), ISSN 2221-4062 (online)
Publisher: South African Society for Animal Science
http://dx.doi.org/10.4314/sajas.v52i5.09

animals (Polish Journal of Laws 2007, No. 133, par. 921); however, they retain many of their wild characteristics. Comprehensive analysis of behavioural changes conducted by deer breeders can be helpful in the determination of the time of separation of fawns from does, establishment of breeding groups, and adjustment of pens for rearing young animals. Additionally, the knowledge of the time when any disturbance in the natural behaviour of animals should be avoided may contribute to the improvement of their welfare (Janiszewski *et al.,* 2016; 2018).

Fallow deer create many types of social groups whose composition depends on, for example, the season of the year, the mating season, and their age or sex. They live in same-sex groups for most of the year. These groups change their structure during the perinatal period (spring/summer) when pregnant does separate from the herd in search of a suitable place for calving and during the mating season (October/November), when male herds break up and each buck tries to create his harem of does. A characteristic group is the so-called “kindergarten”, i.e., a group of 2-month-old fawns playing and foraging together at a short distance from the does. Over time, these groups disintegrate and the juveniles join the doe herd (Cilulko, 2011 a, b; Janiszewski *et al*., 2014).

The bond between the mother and the offspring established immediately after giving birth is extremely important. The mother delicately marks the fawn with saliva and recognizes it by the smell (Arman, 1974). The fawn remains hidden for several consecutive days. Initially, it is visited by the mother many times, but the visits last only several minutes. The older the fawn is, the less frequent the mother’s visits are; however, the interactions are longer (Arman, 1974; Bartoš *et al*., 2001a, b; Janiszewski *et al.,* 2018). After a few days, the doe encourages the fawn, usually through vocalization and nose touching, to cover short distances together (Cilulko, 2011a, b). During the visits to see the fawn, the doe is very attentive, careful, and alert. When uninvited guests are perceived in the vicinity of the hideout, the mother does not approach it and is able to move the fawn to a new place within 24 hours (Clutton-Brock & Guinness, 1975).

It has been shown that climate change, rising temperature, and changing rainfall and wind can affect animal activity (Walther *et al*., 2002; Bowler *et al*., 2017). This was confirmed by observations in Spain, where primarily a decrease in rainfall was associated with a higher degree of polygyny and opportunity for sexual selection (Millán *et al*., 2021). Regarding reproductive behaviour, red deer populations have been observed to shift breeding phenology in populations in response to climate variations (Langvatn *et al*., 2004). Other authors found that the later calving times were related to the late onset of plant phenology (Loe *et al*., 2005; Pettorelli *et al*., 2005; Post *et al*., 1997; Paoli *et al*., 2018).

Therefore, the aim of the study was to analyse changes in the behaviour of fawns during early rearing by does and to demonstrate the influence of weather conditions on suckling and other behavioural elements in farmed fallow deer.

Material and Methods

The observations were carried out at the Research Station of the Institute of Parasitology, Polish Academy of Sciences, Kosewo Górne (N: 53º48'; E: 21º23') in July 2017 and 2018. The animals were observed every second day from 07:00 to 09:30 in the morning and from 18:00 to 20:30 in the evening. The study group was a herd of fallow deer with limited contact with humans. The group consisted of 70 does in the first year of the study and 64 does in the second year; 70% to 80% of the does gave birth to a fawn. The observations were carried out from a distance of 85–355 meters, depending on the location of the animals. The observed group occupied three pens with a total area of 9.5 ha located on a hilly, grassy terrain with many trees and water ponds. The contact of the animals with humans was limited to weekly site inspections and workers driving agricultural vehicles. The distance between the pens and buildings ranged from 90–600 m. The observations were carried out with the use of a camera (NIKON D70s), a binocular, and a sound recorder (ZOOM H6). The observations of the herds were focused on behaviour related to the offspring rearing period, following the prepared ethogram (Table 1). Additionally, the duration of some behaviours was measured: playing, lying in a group, feeding the fawn, allosuckling, grass picking. The animals were identified mainly by the colour of the coat and the numbers on the ear tags.

The weather conditions were recorded using a thermometer with a hygrometer and weather maps from a nearby meteorological station (Institute of Meteorology and Water Management; Maritime Department; Meteorological station). Ethical clearance for this research by Poland law is not required.

The results are expressed as the mean value and standard deviation. The Shapiro–Wilk test was used for the analysis of the distribution of the studied variables. The Student *t*-test and the Mann–Whitney test were used to compare the behaviour of the fawns and to compare the atmospheric conditions between the years. The simple correlations between the number of fawn behaviours and the atmospheric conditions were

assessed using the Spearman rank correlation coefficient. All relationships were evaluated at the significance level of P <0.05. The statistical analyses were performed using Statistica 9.1 software (StatSoft, Poland).

Table 1 Ethogram of fawn behaviour during the rearing period

Behaviour category	Types of behaviour	Description
social behaviour	lying in a mixed group	lying down in a group where other fawns were
	disconnecting from the herd	departing from other individuals of the group
	playing between the fawns	biting, catching between calves, touching foreheads
locomotor behaviour	slow walk	slow movement
	running	moving at a fast pace
	jumping	jumping on four legs at once
food behaviour	suckling own mother	fawn suckles from the hind that gave birth to it from the side in a forward tilted position
	suck foreign mother	fawn suckles a non-bearing doe from the side in a forward tilted position
	group sucking doe	several fawns suck on the doe
	the mother pushing the calf away from sipping milk	the doe drives away the suckling fawn
	grazing	getting the food from the pasture
	drinking water	drawing water from drinkers or from natural water reservoirs
	licking licks	licking the contents of a specialized industrial lick with micro and macro elements, provided in buckets
comfortable behaviour	mud bath in the lake	prolonged stay (walking, standing) in the water in a natural water reservoir in the grazing area
	care	licking the surface of the body
		scratching itself using either a foot or its head
	hiding in tall grasses in sunny weather	prolonged stay in a lying position (with head raised) among higher grassy vegetation growing in the grazing area
communication between mother and calf	a mother's call	fawns make the characteristic noises to which its mother responds
	following the mother	fawns follow their moving mother
	hiding calves	the doe leaves the fawn in high vegetation
stressful behaviour	moving along the fence	walking along the mesh fence in the pasture pens

Results

The atmospheric conditions in both study years were compared (Table 2). Higher values of the mean, morning, and evening temperatures were recorded in the second year of the study (P <0.05). This resulted in differences in the air humidity between the study years, i.e. it was higher (mean, morning, and evening) in the first year of the observations (P <0.05). There were no differences in the amount of rainfall or wind speed between the years (Table 2, P <0.05).

Table 2 Comparison of weather conditions in 2017 and 2018 during the fawn observation periods

Analysed variable			2017		2018		t^a/U^b	p
			M	SD	M	SD		
temperature	average	°C	17.42	1.82	21.56	1.76	14.500[b]	<0.001*
	morning		16.25	1.74	20.33	2.02	-6.747[a]	<0.001*
	evening		18.60	2.89	22.80	1.93	-4.861[a]	<0.001*
air humidity	average	%	67.70	13.46	58.50	7.42	75.000[b]	0.017*
	morning		68.05	20.66	60.33	9.15	2.577[a]	0.015*
	evening		67.35	14.47	56.66	8.59	2.723[a]	0.0104*
rainfall	average	%	22.00	39.64	0	0	112.500[b]	0.214
	morning		22.00	39.64	0	0	112.500[b]	0.214
	evening		0	0	0	0	-	-
wind speed	average	km/h	10.27	6.37	11.13	3.97	113.000[b]	0.227
	morning		9.40	5.96	11.93	5.50	102.000[b]	0.114
	evening		11.15	7.57	10.33	4.77	147.000[b]	0.934

M, mean; SD, standard deviation; t^a, Student's *t*-test result; U^b, Mann–Whitney test results; * statistically significant values at $P < 0.05$

The frequency of behaviours in both study years was compared (Table 3). The fawns followed their mothers with a significantly higher frequency (morning and evening) in the second year of the study, as in the case of running. They displayed a higher frequency of jumping (total number) and grooming behaviour (morning, evening, and total) in the first year of the study (P <0.05). The fallow deer vocalized to call their mothers more frequently in the first months of life (evening) and in the second year of the study (evening and total). The fawns were fed by their mothers and were engaged in allosuckling with a higher frequency (evening and total) in the second year of the study (P <0.05). They switched to solid food (available vegetation - grass picking) more often (morning) in the first year of the study (P <0.05). They displayed symptoms of stress significantly more frequently (evening and total) in the first year of the study (P <0.05, Table 3). The fawns were suckled by their mothers for a longer time in the morning and evening hours, i.e. from 0.916 to 1.036 minutes in the first year of the study (P <0.05, Table 4).

The behaviours of the animals were correlated with the atmospheric conditions (Table 5). The frequency of following the does by the fawns was positively correlated with the morning and evening temperature and negatively correlated with the mean humidity (P <0.05). The animals engaged in running with a higher frequency at a higher morning temperature and a higher mean wind speed (P <0.05). However, such activities as jumping and grooming were negatively correlated with the morning, evening, and mean temperature. Moreover, the fawns engaged in jumping more frequently in the morning when the air humidity increased, whereas an increase in the mean wind speed was associated with a lower frequency of grooming (P <0.05). The frequency of vocalization was higher at an increasing air temperature. The frequency of suckling bouts was positively correlated with the mean air temperature and negatively correlated with the evening hours and the mean air humidity (P <0.05). The animals picked grass with a higher frequency when the air humidity increased in the morning (P <0.05, Table 5). The suckling bout duration was negatively correlated with the air temperature (morning and evening) (Table 6). The frequency of allosuckling was positively correlated with the wind speed in the morning (P <0.05, Table 6).

Table 3 Comparison of the frequency of individual behaviours of fawns in 2017 and 2018

Analysed variable		2017		2018		t^a/U^b	p
		M	SD	M	SD		
lying in a group	morning	7.05	4.60	9.46	4.99	-1.482[a]	0.148
	evening	7.90	4.30	8.06	3.59	-0.121[a]	0.904
	sum	14.95	7.56	17.53	6.85	-1.040[a]	0.306
hiding fawns	morning	0.90	3.16	0.00	0.00	127.500[b]	0.458
	evening	0.35	0.58	0.13	0.35	124.000[b]	0.400
	sum	1.25	3.16	0.13	0.35	107.000[b]	0.158
following the doe	morning	0.75	1.48	3.06	2.43	54.000[b]	<0.001*
	evening	0.60	1.60	4.66	4.27	19.000[b]	<0.001*
	sum	1.35	2.05	7.73	5.52	21.500[b]	<0.001*
running	morning	0.30	0.47	1.13	1.06	73.000[b]	0.009*
	evening	1.25	1.25	0.86	0.99	125.500[b]	0.419
	sum	1.55	1.23	2.00	1.25	-1.060[a]	0.296
jumping	morning	0.20	0.41	0.00	0.00	120.000[b]	0.329
	evening	0.95	1.35	0.13	0.35	91.000[b]	0.050
	sum	1.15	1.42	0.13	0.35	75.000[b]	0.011*
care	morning	2.40	1.63	0.60	1.54	50.000[b]	<0.001*
	evening	1.80	1.39	0.66	1.44	72.500[b]	0.008*
	sum	4.20	1.96	1.26	2.12	49.500[b]	<0.001*
a mother's call	morning	0.40	0.68	1.46	1.92	102.000[b]	0.114
	evening	0.70	1.03	1.73	1.03	67.000[b]	0.004*
	sum	1.10	1.33	3.20	1.97	55.500[b]	0.001*
suckling own mother	morning	0.68	0.82	1.73	1.53	87.000[b]	0.055
	evening	0.95	1.39	2.66	1.11	50.000[b]	<0.001*
	sum	1.60	1.63	4.40	2.02	43.000[b]	<0.001*
suckling another doe	morning	1.00	1.12	2.73	3.08	117.000[b]	0.282
	evening	1.65	2.56	4.53	3.02	65.000[b]	0.003*
	sum	2.65	3.13	7.26	5.09	66.000[b]	0.004*
group sucking doe	morning	0.05	0.22	0.00	0.00	142.500[b]	0.805
	evening	0.05	0.22	0.00	0.00	142.500[b]	0.805
	sum	0.10	0.30	0.00	0.00	135.000[b]	0.633
the mother pushing the fawn away from sipping milk	morning	0.05	0.22	0.06	0.25	147.500[b]	0.934
	evening	0.10	0.44	0.06	0.25	148.000[b]	0.961
	sum	0.15	0.48	0.13	0.35	146.000[b]	0.908
grazing	morning	7.75	4.52	4.73	4.19	86.000[b]	0.033*
	evening	9.00	4.69	8.26	6.73	0.380[a]	0.706
	sum	16.75	7.85	13.00	8.65	0.190[a]	0.190
behaviour stress	morning	1.25	1.01	0.66	1.04	95.500[b]	0.068
	evening	0.85	0.58	0.40	0.63	90.000[b]	0.046*
	sum	2.10	1.37	1.06	1.33	83.000[b]	0.025*

M, mean; SD, standard deviation; t^a, Student's *t*-test result; U^b, Mann–Whitney test results; * statistically significant values at $P < 0.05$

Table 4 Comparison of the duration of individual behaviours of fawns in 2017 and 2018

Time of activity (minutes)		2017		2018		U	p
		M	SD	M	SD		
playing between the calves	morning	2.00	0.00	0	-	0.00	0.000
	evening	7.20	5.14	10.00	-	0.00	0.000
	sum	6.33	5.07	10.00	-	0.00	0.000
lying in a group	morning	54.15	37.48	41.66	20.20	13.00	0.811
	evening	45.80	38.10	25.00	13.22	21.50	0.600
	sum	75.88	54.69	50.00	32.91	28.00	0.538
suckling own mother	morning	0.91	0.20	0.61	0.08	9.00	0.022*
	evening	1.03	0.23	0.62	0.14	11.00	<0.001*
	sum	1.05	0.66	1.09	0.29	127.50	0.927
suckling another doe	morning	nd	nd	0.54	0.10	-	-
	evening	nd	nd	0.51	0.09	-	-
	sum	nd	nd	0.93	0.26	-	-
grazing	morning	24.76	12.07	nd	nd	-	-
	evening	32.77	33.38	15.00	5.00	12.00	0.250
	sum	49.28	42.54	15.00	5.00	9.00	0.129

M, mean; SD, standard deviation; t^a, Student's *t*-test result; U^b, Mann–Whitney test results; * statistically significant values at $P < 0.05$; nd, no data

Table 5 The relationship between the frequency of fawn behaviour and weather conditions during the observation period

Analysed variable		Temperature [°C]			Air humidity [%]			Wind speed [km/h]			Rainfall [%]	
		morning	evening	average	morning	evening	average	morning	evening	average	morning	average
lying in a group	morning	0.224 P=0.194	-	-	0.122 P=0.484	-	-	-0.006 P=0.972	-	-	-0.089 P=0.611	-
	evening	-	0.259 P=0.133	-	-	-0.138 P=0.430	-	-	0.117 P=0.504	-	-	-
	sum		-	0.266 P=0.122	-	-	0.057 P=0.743	-	-	-0.047 P=0.787	-	-0.103 P=0.557
hiding fawns	morning	-0.033 P=0.852	-	-	0.061 P=0.726	-	-	0.049 P=0.778	-	-	-0.124 P=0.476	-
	evening	-	-0.148 P=0.396	-	-	0.122 P=0.486	-	-	-0.001 P=0.995	-	-	-
	sum	-	-	-0.142 P=0.416	-	-	-0.064 P=0.715	-	-	-0.096 P=0.583	-	0.043 P=0.805
following the doe	morning	0.610 P=0.0001*	-	-	-0.228 P=0.187	-	-	0.280 P=0.103	-	-	-0.187 P=0.282	-
	evening		0.445 P=0.007*	-	-	-0.301 P=0.079	-	-	0.092 P=0.597	-	-	-
	sum		-	0.715 P<0.001*	-	-	-0.486 P=0.003*	-	-	0.233 P=0.178	-	-0.287 P=0.094
running	morning	0.352 P=0.038*	-	-	0.008 P=0.962	-	-	0.195 P=0.261	-	-	-0.229 P=0.185	-
	evening	-	-0.297 P=0.083	-	-	0.275 P=0.109	-	-	0.299 P=0.081	-	-	-
	sum	-	-	0.048 P=0.782	-	-	0.305 P=0.074	-	-	0.397 P=0.018*	-	0.059 P=0.736
jumping	morning	-0.336 P=0.048*	-	-	0.462 P=0.005*	-	-	0.108 P=0.538	-	-	0.110 P=0.530	-
	evening	-	-0.454 P=0.006*	-	-	0.282 P=0.101	-	-	0.204 P=0.239	-	-	-
	sum	-	-	-0.441 P=0.008*	-	-	0.329 P=0.054	-	-	0.009 P=0.959	-	0.217 P=0.210
care	morning	-0.404 P=0.016*	-	-	0.319 P=0.062	-	-	-0.220 P=0.205	-	-	0.265 P=0.124	-
	evening	-	-0.365 P=0.031*	-	-	0.304 P=0.075	-	-	-0.190 P=0.274	-	-	-
	sum	-	-	-0.476 P=0.003*	-	-	0.168 P=0.335	-	-	-0.351 P=0.039*	-	0.181 P=0.299
a mother's call	morning	0.115 P=0.509	-	-	0.124 P=0.478	-	-	-0.102 P=0.559	-	-	-0.032 P=0.855	-
	evening	-	0.230 P=0.183	-	-	-0.217 P=0.211	-	-	0.098 P=0.577	-	-	-
	sum	-	-	0.399 P=0.017*	-	-	-0.190 P=0.273	-	-	0.110 P=0.528	-	-0.234 P=0.175
suckling own	morning	0.262	-	-	-0.049	-	-	0.118	-	-	0.018	-

Analysed variable		Temperature [°C]			Air humidity [%]			Wind speed [km/h]			Rainfall [%]	
		morning	evening	average	morning	evening	average	morning	evening	average	morning	average
mother		P=0.134			P=0.784		P=0.506			P=0.919		
	evening	-	0.208 P=0.231	-	-	-0.433 P=0.009*	-	-	-0.134 P=0.443	-	-	-
	sum	-	-	0.404 P=0.016*	-	-	-0.484 P=0.003*	-	-	0.039 P=0.823	-	-0.189 P=0.276
suckling another doe	morning	0.119 P=0.497	-	-	0.081 P=0.642	-	-	-0.096 P=0.582	-	-	-0.100 P=0.566	-
	evening	-	0.208 P=0.231	-	-	-0.190 P=0.275	-	-	-0.186 P=0.285	-	-	-
	sum	-	-	0.290 P=0.091	-	-	-0.239 P=0.167	-	-	-0.110 P=0.531	-	-0.213 P=0.219
group suckling doe	morning	-0.282 P=0.100	-	-	0.214 P=0.216	-	-	-0.017 P=0.922	-	-	-0.070 P=0.690	-
	evening	-	-0.129 P=0.462	-	-	-0.283 P=0.167	-	-	0.129 P=0.457	-	-	-
	sum	-	-	-0.306 P=0.073	-	-	-0.171 P=0.325	-	-	-0.061 P=0.725	-	-0.100 P=0.567
the mother pushing the fawn away from sipping milk	morning	-0.184 P=0.289	-	-	0.000 P=1.000	-	-	0.172 P=0.323	-	-	-0.100 P=0.567	-
	evening	-	0.072 P=0.679	-	-	0.207 P=0.234	-	-	0.023 P=0.894	-	-	-
	sum	-	-	0.027 P=0.878	-	-	-0.042 P=0.811	-	-	-0.022 P=0.900	-	-0.146 P=0.403
grazing	morning	-0.177 P=0.308	-	-	0.361 P=0.033*	-	-	-0.073 P=0.678	-	-	0.113 P=0.519	-
	evening	-	-0.040 P=0.819	-	-	0.034 P=0.846	-	-	-0.105 P=0.548	-	-	-
	sum	-	-	-0.204 P=0.240	-	-	0.224 P=0.196	-	-	-0.238 P=0.168	-	0.060 P=0.734
behaviour stress	morning	-0.206 P=0.235	-	-	0.009 P=0.958	-	-	-0.015 P=0.929	-	-	0.010 P=0.952	-
	evening	-	-0.006 P=0.972	-	-	-0.003 P=0.984	-	-	0.078 P=0.656	-	-	-
	sum	-	-	-0.214 P=0.217	-	-	0.117 P=0.504	-	-	0.005 P=0.976	-	0.064 P=0.716

* statistically significant values at $P < 0.05$

1 Table 6 Relationship between the activity time fawns and the weather conditions during the observation period

		Temperature [°C]			Air humidity [%]			Wind speed [km/h]			Rainfall [%]	
Time of activity (minutes)		**morning**	**evening**	**average**	**morning**	**evening**	**average**	**morning**	**evening**	**average**	**morning**	**average**
playing between the fawns	evening	-	-0.308 P=0.356	-	-	0.153 P=0.653	-	-	-0.251 P=0.456	-	-	-
	sum	-	-	0.006 P=0.985	-	-	-0.003 P=0.993	-	-	0.022 P=0.942	-	-0.394 P=0.183
lying in a group	morning	0.205 P=0.501	-	-	0.199 P=0.515	-	-	-0.083 P=0.787	-	-	-0.119 P=0.698	-
	evening	-	-0.154 P=0.506	-	-	0.153 P=0.506	-	-	0.010 P=0.965	-	-	-
	sum	-	-	0.028 P=0.901	-	-	0.372 P=0.088	-	-	-0.069 P=0.759	-	0.326 P=0.139
suckling own mother	morning	-0.680 P=0.003*	-	-	0.348 P=0.186	-	-	-0.135 P=0.618	-	-	0.459 P=0.073	-
	evening	-	-0.504 P=0.006*	-	-	0.169 P=0.390	-	-	-0.072 P=0.714	-	-	-
	sum	-	-	0.029 P=0.871	-	-	0.086 P=0.632	-	-	-0.011 P=0.951	-	0.183 P=0.308
suckling another doe	morning	-0.150 P=0.678	-	-	-0.133 P=0.715	-	-	0.648 P=0.043*	-	-	-	-
	evening	-	0.045 P=0.884	-	-	-0.167 P=0.585	-	-	-0.387 P=0.191	-	-	-
	sum	-	-	0.134 P=0.662	-	-	-0.259 P=0.392	-	-	0.078 P=0.800	-	-
grazing	morning	0.520 P=0.123	-	-	0.171 P=0.637	-	-	0.276 P=0.440	-	-	-0.127 P=0.726	-
	evening	-	-0.195 P=0.439	-	-	0.029 P=0.910	-	-	-0.345 P=0.161	-	-	-
	sum	-	-	-0.287 P=0.248	-	-	0.052 P=0.838	-	-	-0.307 P=0.215	-	0.218 P=0.384

2 * statistically significant values at $P < 0.05$

Discussion

Already in the first month of life, fallow deer perform a certain daily ritual of playing and running. They especially like playing before sunset for a few minutes to approximately half an hour. As observed by Krzywiński *et al*. (1984), fallow deer sometimes play during the day, for example, after a long rain. Playing begins with a funny jumping on four legs at once. Fawns jump high and kick up their heels like wild horses. After a while, the entire herd gallops and bucks. They usually run in circles. While galloping or bucking, they sometimes run into each other or another obstacle (Krzywiński *et al*., 1984). Such behaviours were noted in the groups of fallow deer observed in the present study. Chapman & Chapman (1980) described the ritual of evening play in fallow deer. This type of behaviour in young fallow deer is typical of this species. This was confirmed by the observations of the farmed fallow deer, which on average played for 6–10 minutes daily, with 7–10 minutes of the evening playing ritual.

Atmospheric conditions may influence the behaviour of farmed fallow deer fawns. Many research results confirm that cervids exhibit the highest activity at sunrise and sunset (Feighny *et al*., 2006; Pépin *et al*., 2009), which was confirmed in the present study of farmed fallow deer.

The study carried out by Prebanić & Ugarković (2015) reported no correlation between the activity of cervids and air temperature. In contrast, the present observations of the farmed fallow deer contradict this observation. The activity of animals, i.e., running and jumping, was shown to be correlated with the temperature; moreover, the fawns spent more time on food intake when the air temperature decreased. Douhard *et al.* (2013) and Volodin *et al.* (2013, 2015) also reported a negative correlation between the temperature and the roaring index in deer, which can be explained by a reduction in animal activity accompanying a rise in the temperature. In turn, the fawns observed in the present study vocalized to call the does with a higher frequency at an increased air temperature.

The air humidity level exerted an influence on some of the fallow deer behaviours (jumping, suckling, grazing). The results reported by Bocci *et al.* (2013) indicate that the frequency of some activities of cervids decrease along with an increase in humidity, whereas the present observations do not confirm such a relationship. Interestingly, it was shown that the force of the wind speed had an impact on the frequency of allosuckling/milk theft, grooming, and running. It is possible that weather conditions, especially wind, have an influence on the smell, i.e., odours suspended in the air and odour plumes; hence, the behaviour of cervids should be influenced by these factors, as these animals recognize each other by smell. This was confirmed by Ruzicka & Conover (2011), who indicated that the wind speed had an impact on the general behaviour of many species.

As shown by Kelly & Drew (1976), the number of suckling bouts per day ranges from one to seven; mostly only one to three suckling bouts were noted, which did not change with the age of the animal. Similar results were obtained in the present study, where the frequency of suckling bouts ranged from 1.6–4.4 times. In studies of deer, the number of suckling bouts and the mean total suckling bout duration in each period decrease with the age of the calf. The mean number of suckling bouts decreased from 2.8 at the age of 1–7 days to 1.2 at 15–28 days of age, and the mean total duration of the suckling bouts decreased from 149 s to 82–85 s in the same period, with subsequent slight changes in both values (Kelly & Drew, 1976). In the present study of fallow deer fawns, the shorter suckling bouts (60–61 s) were probably associated with the age of the animals, as our observations were carried out 2–3 weeks after the fawns were born. As reported by Wilson & Haigh (2007), in the first weeks after birth, the doe spends only a few minutes a day with the offspring due to the very short suckling duration in this period. Mulley (2007) observed that the feeding frequency in fallow deer may vary substantially between breeding systems. The author reported that fawns were fed 7–8 times a day in an intensive farming system and only 4–5 times in an extensive farming system. The suckling bout frequencies reported in the present study are similar to those observed by Clutton-Brock & Guinness (1975) in cervids and by Mulley (2007) and Janiszewski *et al.* (2018) in extensive fallow deer breeding. Moreover, the feeding activity was concentrated in the morning and in the evening, as shown by Mattiello *et al.* (1997).

Unlike other cervid species, fallow deer exhibit so-called ‘allosuckling’ behaviour, i.e., suckling from a doe other than the mother. The strategy of continued milk production if the female does not mate might serve to increase survival chances of the fawn at little extra cost for the mother (Clutton-Brock *et al.*, 1982). It was shown that a doe whose fawn died at 7 w of age continued to produce milk during the whole lactation. This seems to suggest that crosssuckling in deer might occur at relatively high frequencies (Landete-Castillejos *et al*., 2000). The present observations of young farmed fallow deer confirm the results reported by other researchers. The fawns allosuckled on average 2–7 times a day and spent 56 s on this activity. Ekvall (1998) investigated the occurrence, frequency, and distribution of allosuckling in a wild population of fallow deer throughout the lactation period in southern Sweden. A total of 292 suckling bouts were observed in four

groups; in 43% of these, fawns were seen sucking from a female that was not the mother. A higher percentage of suckling bouts was recorded as the lactation period progressed and all 16 fawns participated to various degrees. Of the 16 females, 13 suckled non-offspring fawns, but their behaviour towards these fawns varied greatly. In the present study carried out on the farm, the does were observed to push the fawn away to prevent allosuckling. As reported by Barrette and Gauthier (1985), in comparison with white-tailed deer mothers, fallow deer mothers are much more aggressive toward alien fawns and spend more time close to their own fawns. They propose that weaning starts at about 20 days of age in both species. This is the time when the mother terminates more than half of all suckling bouts, terminates more bouts than she initiates, and suckles are shorter when she initiates, compared to when it is her fawn that initiates the suckling.

Conclusion

In summary, a higher frequency of fawn activities was noted in morning and evening hours. The playing ritual and the suckling bouts were most often noted in the evening. The activity of the fawns (e.g., jumping) increased with a decrease in air temperature. At an increased air temperature and reduced humidity, the fawns followed and called the does more frequently, probably to persuade them to hide in a shaded place. The suckling bouts exhibited a higher frequency with increasing air temperature and humidity, but their duration was shorter at the higher air temperature. A greater wind speed was accompanied by a higher allosuckling frequency. As indicated by the study, the natural behaviour of young fallow deer, which has an impact on their future functioning in the herd, should not be disturbed in the morning and evening.

Authors' Contributions

KT (ORCID) and PJ (ORCID) participated in designing the study, manuscript writing, were involved in drafting and revising the manuscript for intellectual content, carried out data analysis and interpretation, and were involved in the preparation and revision of the manuscript. ŻSB (ORCID) contributed to the acquisition, analysis, and interpretation of data. All authors reviewed and approved the manuscript before it is submitted for publication.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

Arman, P.,1974. A note on parturition and maternal behaviour in captive red deer (*Cervus elaphus* L.). Reprod. Fertil. Dev. 37, 87-90.

Barrette, C. & Gauthier, D., 1985. Suckling and Weaning in Captive White-Tailed and Fallow Deer. Behaviour, 94(1-2), 128-149. doi: https://doi.org/10.1163/156853985X00307

Bartoš, L., Cízová-Schröffelová, D., Jandurová, O., Nespor, F. & Vaňková, D., 2001a. Mother–offspring bonding in farmed red deer: Accuracy of visual observation verified by DNA analysis. Appl. Anim. Behav. Sci. 71, 157-165.

Bartoš, L., Vaňková, D., Hyánek, J. & Šiler, J. 2001b. Impact of allosucking on growth of farmed red deer calves (*Cervus elaphus*). Appl. Anim. Behav. Sci. 72, 493-500.

Bowler, D.E., Hof, C., Haase, P., Kröncke, I., Schweiger, O., Adrian, R., et al., 2017. Cross-realm assessment of climate change impacts on species' abundance trends. Nat. Ecol. Evol. 1(3), 1–7. https://doi.org/10.1038/s41559-016-0067 PMID: 28812743

Burghardt, G.M., 2005. The Genesis of Animal Play: Testing the Limits. MIT Press: Cambridge.

Burghardt, G.M., 2011. Defining and Recognising Play. In: The Oxford Handbook of Development of Play. Ed. Pellegrini, A.D., 9-18. OUP: Oxford.

Carter, R.N., Romanow, C.A., Pellis, S.M. & Single, S., 2019. Play for prey: Do deer fawns play to develop species-typical anti predator tactics or to prepare for the unexpected? Anim. Behav. 156, 31-40.

Chapman, N.G. & Chapman, D.I., 1980. The distribution of fallow deer: a worldwide review. Mammal Rev. 10 (3), 61-130.

Cilulko, J., 2011a. Deer reproduction. Th. 1. Selected aspects of reproductive biology. Breeding Review 5/2011: 26-31.

Cilulko, J., 2011b. Deer reproduction. Th. 2. Managing the reproductive processes on the farm. Breeding Review 6/2011: 23-27.

Clutton-Brock, T.H. & Guinness, F.E., 1975. Behaviour of Red Deer (*Cervus Elaphus* L.) at calving time. Behaviour 3 (55), 287-300.

Clutton-Brock, T.H., Guinness, F.E., & Albon, S. D., 1982a. Red deer: Behaviour and Ecology of Two Sexes. Edinburgh Univ. Press, Edinburgh.

Douhard, M., Bonenfant, C., Gaillard, J.-M., Hamann, J.-L. & Jacques, M.G., 2013. Roaring counts are not suitable for the monitoring of red deer (*Cervus elaphus)* population abundance. Wildlife Biol. 19(1), 94-101. DOI: 10.15298/rusjtheriol.15.2.03

Ekvall, K., 1998. Effects of social organization, age and aggressive behaviour on allosuckling in wild fallow deer. Anim Behav. 56(3): 695-703. https://doi.org/10.1006/anbe.1998.0825

Feighny, J.A., Williamson, K.E. & Clarke, J.A., 2006. North American elk bugle vocalizations: Male and female bugle call structure and context. J. Mammal. 87, 1072-1077. https://doi.org/10.1644/06-MAMM-A-079R2.1

Janiszewski, P., Bogdaszewski, M., Murawska, D. & Tajchman, K., 2016. Welfare of farmed deer -practical aspects. Pol. J. Natur. Sc. 31(3), 345-361

Janiszewski, P., Bogdaszewska, Z., Bogdaszewski, M., Bogdaszewski, P., Cilulko-Dołęga, J., Nasiadka, P. & Steiner, Ż., 2014. Breeding and Farm Breeding of Deer. Publishing house UWM, Olsztyn.

Janiszewski, P., Cilulko-Dołęga, J., Murawska, D. & Bogdaszewski, M., 2018. Interactions between fawns and does of farmed fallow deer, *Dama dama,* in the postnatal period. Anim. Sci. J. 89, 483–487.

Kelly, R.W. & Drew, K.R., 1976. Shelter seeking and sucking behaviour of the red deer calf (*Cervus elaphus*) in a farmed situation. Appl. Anim. Ethol. 2 (2), 101-111.

Krzywiński, A., Niedbalska, A. & Twardowski, L., 1984. Growth and development of hand reared fallow deer fawns. Acta Theriol. 29(29), 349-356.

Landete-Castillejos, T., Garcia, A., Molina, P., Vergara, H., Garde, J., & Gallego, L., 2000. Milk production and composition in captive Iberian red deer (*Cervus elaphus hispanicus*): Effect of birth date. J Anim Sci. 78(11), 2771-7. DOI: 10.2527/2000.78112771x

Langvatn, R., Mysterud, A., Stenseth, N.C. & Yoccoz, N.G., 2004. Timing and synchrony of ovulation in red deer constrained by short northern summers. Am. Nat. 163(5), 763–772. https://doi. org/10.1086/383594 PMID: 15122493

Loe, L.E., Bonenfant, C., Mysterud, A., Gaillard, J.M., Langvatn, R., Klein, F., Calenge, C., Ergon, T., Pettorelli, N. & Stenseth, N.C., 2005. Climate predictability and breeding phenology in red deer: Timing and synchrony of rutting and calving in Norway and France. J Anim Ecol 74, 579-588. https://doi.org/10.1111/j.1365-2656.2005.00987.x

Mattiello, S., Mattiangeli, V., Bianchi, L. & Carenzi, C., 1997. Feeding and social behaviour of fallow deer (*Dama dama* L.) under intensive pasture confinement. J. Anim. Sci. 75: 339-347. https://doi.org/10.2527/1997.752339x

Millán, M.F., Carranza, J., Pérez-González, J., Valencia, J., Torres-Porras, J., Seoane, J.M., la Peña, E., Alarcos, S., Sánchez-Prieto, C.B., Castillo, L., Flores, A. & Membrillo, A. 2021. Rainfall decrease and red deer rutting behaviour: Weaker and delayed rutting activity though higher opportunity for sexual selection. PLoS ONE 16(1): e0244802. DOI: https://doi.org/ 10.1371/journal.pone.0244802

Mulley, R.C., 2007. Reproductive Management of Fallow Deer. In: Youngquist, R.S., Threlfall, W.R. (ed.), Current Therapy in Large Animal Theriogenology, 2nd edn. pp. 952– 965. Sunders Elsevier, St. Louis.

Paoli, A., Weladji, R.B., Holand, Ø. & Kumpula, J., 2018. Winter and spring climatic conditions influence timing and synchrony of calving in reindeer. PloS ONE. 13(4): e0195603. https://doi.org/10.1371/journal.pone.0195603 PMID: 29694410

Pépin, D., Morellat, N. & Goulard, M., 2009. Seasonal and daily walking activity patterns of free-ranging adult red deer (*Cervus elaphus*) at the individual level. Eur. J. Wildl. Res. 55, 479-486. DOI: 10.1007/s10344-009-0267-2

Pettorelli, N., Mysterud, A., Yoccoz, N.G., Langvatn, R. & Stenseth, N.C., 2005. Importance of climatological downscaling and plant phenology for red deer in heterogeneous landscapes. Proc. Royal Soc. B. 272(1579), 2357–2364. https://doi.org/10.1098/rspb.2005.3218 PMID: 16243701

Post, E., Stenseth, N.C., Langvatn, R. & Fromentin, J.M., 1997. Global climate change and phenotypic variation among red deer cohorts. Proc. Royal Soc. B. 264(1386), 1317–1324. https://doi.org/10.1098/rspb.1997.0182 PMID: 9332016

Prebanić, I. & Ugarković, D., 2015. Analysis of seasonal activities of red deer (*Cervus elaphus* L.) in relation to the mating season, lunar phases, and air temperature. Russ. J. Ecol. 46(4), 393-395. DOI:10.1134/S1067413615040153

Ruzicka, B. & Conover, M.R., 2011. Influence of wind and humidity on foraging behaviour of olfactory mesopredators. Can Field Nat 125(2). DOI:10.22621/cfn.v125i2.1196

Walther, G.R., Post, E., Convey, P., Menzel, A., Parmesan, C., Beebee, T.J.C., Fromentin, J.M., Hoegh-Guldberg O. & Bairlein F., 2002. Ecological responses to recent climate change. Nature. 416(6879), 389–395. https://doi.org/10.1038/416389a PMID: 11919621

Wilson, P.R. & Haigh, J.C., 2007. Reproductive management of farmed red deer and wapiti, In: Current Therapy in Large Animal Theriogenology, 2nd edn. pp. 943–952. Sunders Elsevier, St. Louis.

Volodin, I.A., Volodina, E.V., Frey, R. & Maymanakova, I.L., 2013. Vocal activity and acoustic structure of the rutting calls of Siberian wapiti (*Cervus elaphus sibiricus*) and their imitation with a hunting luring instrument. Russ. J. Theriol. 12, 99-106. DOI:10.15298/rusjtheriol.12.2.06

Volodin, I.A., Matrosova, V.A., Volodina, E.V., Garcia, A.J., Gallego, L., Márquez, R., Llusia, D., Beltrán, J. & Landete-Castillejos, T., 2015. Sex and age-class differences in calls of Iberian red deer during the rut: Reversed sex dimorphism of pitch and contrasting roars from farmed and wild stags. Acta Ethol. 18(1), 19-29. DOI 10.1007/s10211-013-0179-8