

## Grouping behaviour of Iberian wild goat during the parturition period in the Iberian System

Comportamiento gregario de la cabra montés durante la paridera en el Sistema Ibérico

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The expansion of Iberian wild goat *Capra pyrenaica* Schinz, 1838 in the whole Iberia is due mainly to natural recovery and secondly to reintroductions (García-González *et al.* 2020, in press). This allowed considering it of Least Concern in the IUCN red list (Herrero *et al.* 2020). After centuries of absence, during 1990s it spread in the Iberian System, the largest mountain range in Iberia, affecting Aragon region (Gortázar *et al.* 2000). This expansion continues nowadays (González *et al.* 2013).

In the south of the Iberian Peninsula, there are a number of studies about the ecology, behaviour and reproductive behaviour of the species (Alados 1985a, Alados & Escós 1996, Acevedo & Cassinello 2009, Alados *et al.* 2017). Rut takes place between mid-November and mid-December, while the parturition period occurs from April to June (Alados *et al.* 2017). During rut, males and females group together (Granados *et al.* 2001), while in parturition period, most yearlings and males form separated groups (Alados 1985a) and pregnant females isolate from the group to give birth on their own (Alados & Escós 1988a). Isolating in inaccessible areas during parturition is a strategy to enhance survival of the offspring, which probably decreases chances of predation on the mother and the neonate (O'Brien 1983). Usually, after the first week of life of the goatling, mothers group together and form nurseries (Alados & Escós 1988a). The knowledge on the biology of the rest of the populations, particularly of the Iberian System, is low (Lucas *et al.* 2016, Prada *et al.* 2019).

However, in more general terms and regarding French wild goat populations, some authors suggest

that apart from environmental and reproductive factors, there is a biological factor determining group size: total population size. The bigger the population, the bigger the group size; while in smaller populations, more isolated individuals can be found (Toïgo *et al.* 1996).

In north-eastern Iberia, Iberian wild goat is a huntable species, which produces important economic revenues to the affected hunting grounds (Marco *et al.* 2011). The populations are monitored, and over 3,000 individuals are hunted every year using hunting quotas, as trophies, non-selective hunt and culling to prevent damages. In its whole range, annual monitoring is based on two counts, after parturition and in the rut or one count during rut, to estimate minimum number of living animals or estimate population numbers (Alados 1986, Pérez 2001, Prada *et al.* 2019).

The aim of the study was to describe population parameters and grouping behaviour of an Iberian wild goat population before, during and after the parturition period and to propose the best period to estimate breeding success (goatling per adult female) and population size based on a detailed monitoring.

The study was conducted on a limestone massif close to the village of Mezalocha (41°25'34''N 1°04'59''W) in Saragossa province (Aragon, Spain), located at 488 m.a.s.l during spring and summer of 2018. The climate is semi-arid, with average annual precipitations around 400 mm. Years 2017 (227.6 mm) and 2018 (505.6 mm) had low and high precipitations, respectively (Valdespartera meteorological station, AEMET

OpenData). Additionally, there is an extreme variability of temperatures: often, there are big differences between the low and the high lands, due to altitude and winds coming from the NW.

This study was non-experimental and transversal. We selected the area as a sample of the general context of the species in the Iberian System, due to its appropriate visibility, accessibility, and animal abundance. Potential predators were red fox *Vulpes vulpes* (Linnaeus, 1758) and golden eagle *Aquila chrysaetos* (Linnaeus, 1758).

The studied variables were qualitative (sex, associations) and quantitative (discrete, number of animals; continuous, age of animals). The method used for the description of such variables was visual through the observation of animals. Variables were determined as exactly as possible. Once a week we carried out the surveys by foot. We chose the day of the week in which to carry out the survey depending on the weather forecast, so that best visibility and benign wind conditions were given. Usually, there were at least two rangers of the Regional Government of Aragon in the surveys. It was a 4.5 km walk, which started at dawn, coinciding with the Iberian wild goats' peak of activity (Alados & Escós 1988b), and usually ended about midday.

Surveys started on 28<sup>th</sup> March 2018, close to the beginning of the parturition period (Alados *et al.* 2017), and ended on 27<sup>th</sup> June 2018, when the parturition period was over and no recent parturitions were detected in the previous two weeks. During the surveys, we used binoculars and telescopes to observe every group of animals; we filled up a sheet, with details on the composition of each group and mapped every group, expressing its movement in the map. In addition to group composition, we made observations on female behaviour, twin births, nurseries and presence of other relevant species as raptors or red foxes and we took pictures with a 65x optical zoom camera.

We defined five categories for recognizing individuals, following Alados (1985a). Categories were: Adult females (f), with well-developed horns and maximum body size; Adult males (m), where we established 3 age classes: 2-6 years-old; 7-10 years-old and older, plus a 4<sup>th</sup> age class that was "undetermined males"; Yearlings (y), males and females, between 1 and 2 years, showing smaller horn and body size than adults; Goatlings (g): being born in the parturition period of 2018; Undetermined, individuals whose age and sex were uncertain. However, when it comes to analysing

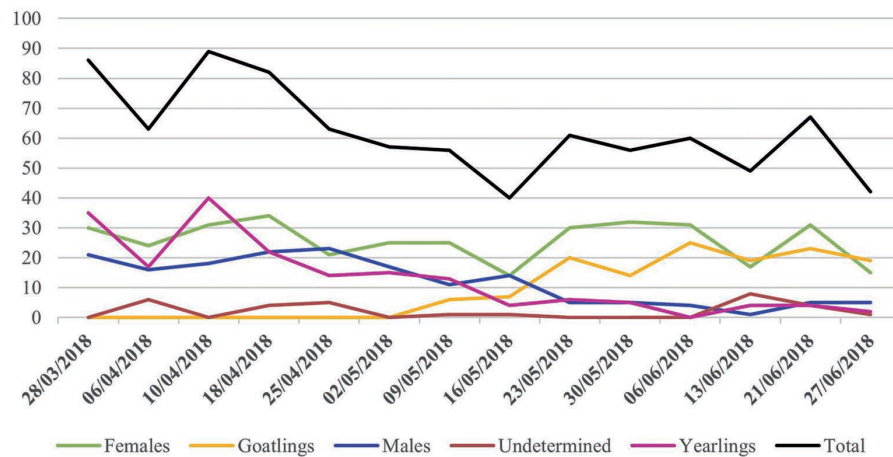
associations, we did not take into account the groups in which the individuals classified in this last category did not allow the association to be defined. For the group definition, we followed Schaller (1977), considering a group as an aggregation of individuals occupying the same patch of habitat, with sensorial contact between them, and more or less coordinated in their movements. Besides, in order to interpret the gregarious behaviour, we defined five association types: Solitary female; Single female with goatling(s) and/or yearling(s); Females on their own and with kids; Adult and yearling male(s) and Mixed groups. Breeding success was calculated by dividing the number of goatlings by the number of adult females. Sex ratio was the number of adult males divided by the number of adult females.

During the study period, we recorded 871 wild goats, distributed in 129 groups. The maximum number of animals (89 individuals) was observed on 10<sup>th</sup> April (Fig. 1) before any goatling was born, while the minimum number of sightings (40 individuals) was on 16<sup>th</sup> May. Sightings of males decrease from 25<sup>th</sup> April onwards, while sightings of females begin to decrease on 18<sup>th</sup> April and increase again on 23<sup>rd</sup> May. The first newborn goatlings were observed on 9<sup>th</sup> May (Fig. 2), and this date was taken as the beginning of the parturition period. Based on mother and goatlings behaviour we estimated on 6<sup>th</sup> June a 41.2% of twin births. Sightings of yearlings decrease after 10<sup>th</sup> April, and from 9<sup>th</sup> May onwards, they remain stable around five individuals. The number of undetermined individuals is low.

Considering the maximum number of observed individuals for each category (23 young males, 12 old males, 34 females, 25 goatlings and 40 yearlings), the minimum number of individuals in this subpopulation is estimated at 134.

The size of groups showed an asymmetrical distribution towards small group sizes (Fig. 3). The most frequent group was of one individual (14.7%) and 42.6% ranged 1-3. Nine groups (7%) were bigger than 20 individuals. The maximum group size was of 42 individuals. Average group size is 6.8 and median group size 4.

We took into account the maximum number of males (35) and females (34) to estimate sex ratio, so the absolute value is 1.03. Nevertheless, there was some gradual change in observed sex ratio (Table 1) as sightings of males become scarcer after the first fortnight of May. Value varied between 1.1 before and 0.06 after parturitions.



**Figure 1.** Number of Iberian wild goats sighted from 28/03 to 27/06 during 2018 in NE Iberia. Animals were classified in different age and sex categories, namely: Females, Goatlings, Males, Undetermined and Yearlings. Goatlings, Undetermined and Yearlings comprise individuals of both sexes.



**Figure 2.** First newborn goatlings observed on May 9th. Picture taken by Alicia García-Serrano.

Regarding breeding success, the maximum number of goatlings was 25 (and 34 females), so absolute breeding success was 0.74. It changed through time, as the number of sighted goatlings increased (Fig. 4). The peak of sighted goatlings was on the first fortnight of June, and highest breeding success values were reached at this point as well.

Associations of all five types appeared. The most frequent association were mixed groups (46 sightings); then female groups with (or without) goatlings (27 sightings) and single female with goatlings (20 sightings, see Table 2). The highest number of solitary females appeared on the second fortnight of May. The highest number of females with goatlings was on the first fortnight of June (Fig. 4). We sighted the highest number of males (23 individuals) before the parturition period, on the second fortnight of April, and the highest number of goatlings on 6<sup>th</sup> June, with 25 individuals. Mixed groups are scattered throughout the whole survey, being especially abundant in April.

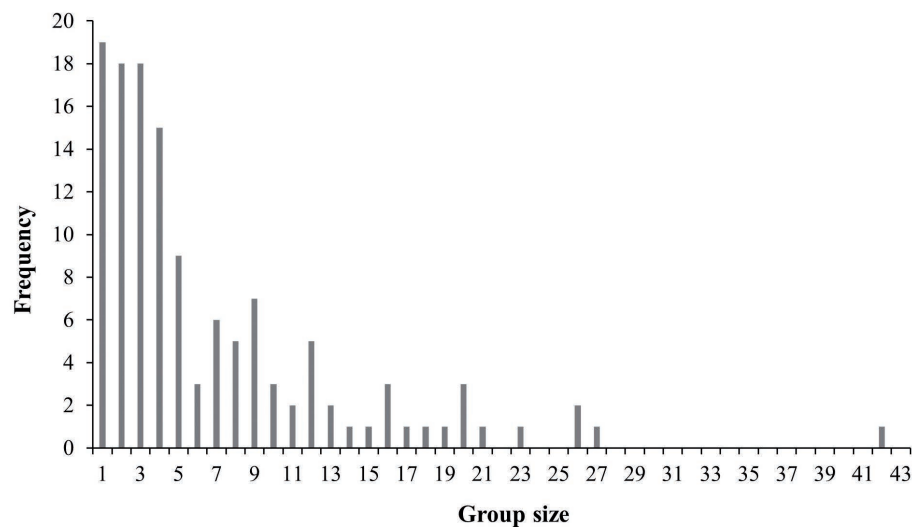
As in many other large herbivores (Gaillard *et al.* 2000), births in Iberian wild goat are synchronous, timed to maximize offspring survival. The phenology and ethology traits were similar to other southern populations: males and females segregate from February onwards (Alados 1985a); yearlings separate from females and form separated groups (Alados & Escós 1996); females isolate themselves before giving birth (Alados *et al.* 2017) and then form nurseries (Granados *et al.* 2001).

The highest number of animals was recorded before the parturition period, according to what happens during rut, when mixed groups predominate and groups size double in size (Prada *et al.* 2019). Therefore, the parturition period is not the best moment to estimate minimum population size.

During 2018 breeding success was high, probably due to the relatively high rainfall, which had effects on primary production and possibly had an impact on high production of goatling twins.

The first goatling was sighted on the first fortnight of May as in southern populations (Alados & Escós 1996). Sightings of males go progressively getting scarcer as parturitions happen, and sightings of females with goatlings become more abundant from middle-May onwards (Alados & Escós 1988a).

Middle-sized groups can be mixed, males' or maternal groups. Mixed groups are much scarcer in parturition period, and their highest abundance is during rut (Alados & Escós 1996). Male or male-juvenile groups form almost exclusively during parturition period; and maternal groups constitute a decisive trait in the gregarious behaviour of females, because it allows lactating females to reduce individual vigilance on their neonate (Alados *et al.* 2017, Alados 1985b).



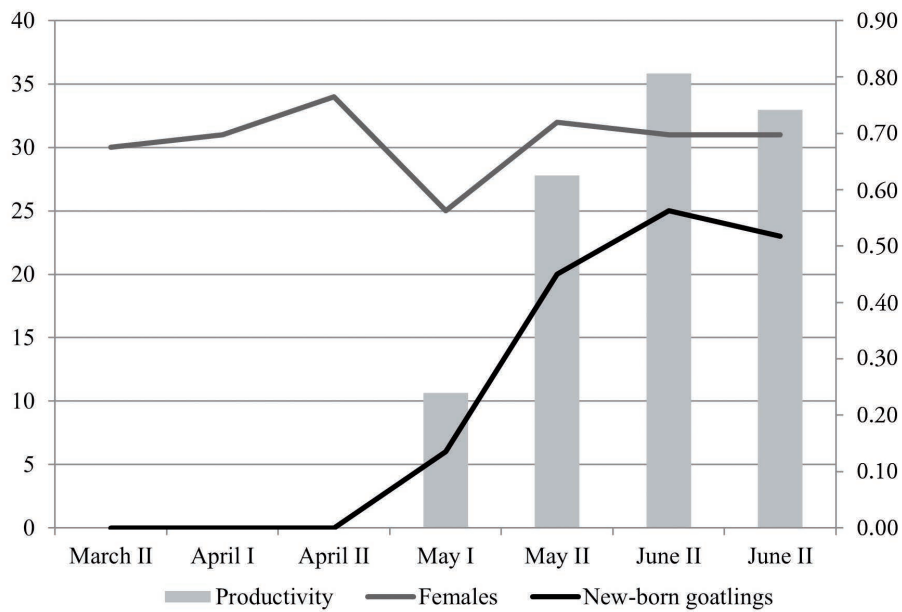
**Figure 3.** Group size frequencies of Iberian wild goats in Mezalocha, Aragon, NE Iberia.

**Table 1.** Evolution of sex ratio throughout the 14 surveys.

Date (dd/mm)	Adult males	Adult females	Sex-ratio
28/03	21	30	0.70
06/04	16	24	0.67
10/04	18	31	0.58
18/04	22	34	0.65
25/04	23	21	1.10
02/05	17	25	0.68
09/05	11	25	0.44
16/05	14	14	1
23/05	5	30	0.17
30/05	5	32	0.16
06/06	4	31	0.13
13/06	1	17	0,06
21/06	5	31	0.16
27/06	5	15	0.33
28/03 to 27/06	35	34	1.03

Changes in sexual segregation alter observed sex ratio and males moving away. Therefore, the best period in which to carry out accurate estimations for males is during rut, when males and females form big mixed groups and males become more conspicuous.

The best period to quantify population breeding success is on the second fortnight of June, when the peak of the parturition period is over, and breeding success value starts to decrease.



**Figure 4.** Breeding success (0-0.9) and number of females and new-born goatlings (0-40) in Mezalocha, NE Iberia, during 2018's breeding season. Data are distributed in biweekly periods.

**Table 2.** Frequencies of each association type.

Date (dd/mm)	Solitary females	Single females with goatlings	Solitary females or with goatlings	Males	Mixed groups	Total
28/03	1	0	1	0	7	9
06/04	0	0	1	1	4	6
10/04	0	0	3	1	2	6
18/04	1	0	1	1	6	9
25/04	0	0	1	0	6	7
02/05	1	0	4	1	3	9
09/05	1	2	0	0	6	9
16/05	2	2	2	1	1	8
23/05	4	4	4	1	3	16
30/05	2	3	4	1	2	12
06/06	2	0	2	1	1	6
13/06	0	1	0	0	1	2
21/06	1	4	2	2	4	13
27/06	0	4	2	2	0	8
Total	15	20	27	12	46	120

## Acknowledgments

This work is part of the long term monitoring of wild ungulates in Aragon, financially supported by its Regional Government.

## References

- Acevedo P. & Cassinello J. 2009. Biology, ecology and status of Iberian ibex *Capra pyrenaica*: a critical review and research prospectus. *Mammal Review*, 39(1): 17-32. DOI: [10.1111/j.1365-2907.2008.00138.x](https://doi.org/10.1111/j.1365-2907.2008.00138.x)
- AEMET OpenData: <https://opendata.aemet.es>. Last consulted: 20/02/2020.
- Alados C.L. 1985a. Group size and composition of the Spanish ibex (*Capra pyrenaica* Schinz) in the Sierras of Cazorla and Segura. Pp: 134-147. In: S. Lovari (ed). *The Biology and Management of Mountain Ungulates*, Springer Netherlands, 271 pp.
- Alados C.L. 1985b. An analysis of vigilance in the Spanish ibex (*Capra pyrenaica*). *Zeitschrift für Tierpsychologie*, 68: 58-64
- Alados C.L. 1986. Spatial structure in groups of Spanish ibex (*Capra pyrenaica*). *Biological Behaviour*, 11: 176-185.
- Alados C.L. & Escós J. 1988a. Parturition dates and mother-kid behavior in Spanish ibex (*Capra pyrenaica*) in Spain. *Journal of Mammalogy*, 69(1): 172-175.
- Alados C.L. & Escós J. 1988b. Alarm calls and flight behaviour in Spanish ibex (*Capra pyrenaica*). *Biological Behaviour*, 13: 11-21.
- Alados C.L. & Escós J. 1996. *Ecología y comportamiento de la cabra montés*. Monografías del Museo Nacional de Ciencias Naturales - CSIC, nº 11, Madrid
- Alados C.L., Escós J. & Cassinello J. 2017. Cabra montés – *Capra pyrenaica* Schinz, 1838. In: L.M. Carrascal & A. Salvador (eds.) *Enciclopedia Virtual de los Vertebrados Españoles* [Internet]. Museo Nacional de Ciencias Naturales, Madrid. Available from <http://www.vertebradosibericos.org/>. Accessed on 3 March 2020.
- Gaillard J.M., Festa-Bianchet M., Yoccoz N.G., Loison A. & Toigo C. 2000. Temporal variation in fitness components and population dynamics of large herbivores. *Annual Review of Ecology and Systematics*, 31(1): 367-393. DOI: [10.1146/annurev.ecolsys.31.1.367](https://doi.org/10.1146/annurev.ecolsys.31.1.367)
- García-González R., Herrero J., Acevedo P., Arnal M.C. & Fernández de Luco D. 2020 (in press). Iberian wild goat *Capra pyrenaica* Schinz, 1838. In: Klaus Hackländer & Frank E. Zachos (eds). *Handbook of the Mammals of Europe*, Springer Verlag, Berlin.
- González J., Herrero J., Prada C. & Marco J. 2013. Changes in wild ungulate populations in Aragon, Spain between 2001 and 2010. *Galemys*, 25: 51-57. DOI: [10.7325/Galemys.2013.A05](https://doi.org/10.7325/Galemys.2013.A05)
- Gortázar C., Herrero J., Villafuerte R. & Marco R. 2000. Historical examination of the status of large mammals in Aragon, Spain. *Mammalia*, 64(4): 411-422. DOI: [10.1515/mamm.2000.64.4.411](https://doi.org/10.1515/mamm.2000.64.4.411)
- Granados J.E., Pérez J.M., Márquez F.J., Serrano E., Soriguer R.C. & Fandos P. 2001. La cabra montés (*Capra pyrenaica*, Schinz 1838). *Galemys* 13(1): 3-37.
- Herrero J., Acevedo P., Arnal M.C., Fernández de Luco D., Fonseca C., García-González R., Pérez J.M. & Sourp E. 2020. *Capra pyrenaica*. The IUCN Red List of Threatened Species 2020: e.T3798A170192604: DOI: [10.2305/IUCN.UK.2020-2.RLTS.T3798A170192604.en](https://doi.org/10.2305/IUCN.UK.2020-2.RLTS.T3798A170192604.en)
- Lucas P.M., Herrero J., Fernández-Arberas O., Prada C., García-Serrano A., Saiz H. & Alados C.L. 2016. Modelling the habitat of a wild ungulate in a semi-arid Mediterranean environment in southwestern Europe: Small cliffs are key predictors of the presence of Iberian wild goat. *Journal of Arid Environments*, 129: 56-63. DOI: [10.1016/j.jaridenv.2016.02.008](https://doi.org/10.1016/j.jaridenv.2016.02.008)
- Marco J., Herrero J., Escudero M.A., Fernández-Arberas O., Ferreres J., García-Serrano A., Jiménez-Anaya A., Labarta J.L., Monrabal L. & Prada C. 2011. Veinte años de seguimiento poblacional de ungulados silvestres de Aragón. *Pirineos*, 166: 135-153. DOI: [10.3989/pirineos.2011.166007](https://doi.org/10.3989/pirineos.2011.166007)
- O'Brien P.H. 1983. Feral goat parturition and lying-out sites: spatial, physical and meteorological characteristics. *Applied Animal Ethology*, 10: 325-339.
- Pérez J.M. 2001. *Distribución, genética y estado sanitario de la cabra montés en Andalucía*. Servicio de Publicaciones, Universidad de Jaén, Jaén, 276 pp.
- Prada C., Herrero J., García-Serrano A., Fernández-Arberas O. & Gómez C. 2019. Estimating Iberian wild goat abundance in a large rugged forest habitat. *Pirineos*, 174: 50-57. DOI: [10.3989/pirineos.2019.174010](https://doi.org/10.3989/pirineos.2019.174010)
- Schaller G.B. 1977. *Mountain monarchs: wild sheep and goats of the Himalaya*. University of Chicago Press, Chicago and London, 425 pp.
- Toigo C., Gaillard J.M. & Michallet J. 1996. La taille des groupes: un bioindicateur de l'effectif des populations de bouquetin des Alpes (*Capra ibex ibex*)? *Mammalia*, 60(3): 463-472. DOI: [10.1515/mamm-1996-0311](https://doi.org/10.1515/mamm-1996-0311)

Submitted: 4 January 2021

Accepted: 8 April 2021

Associate editor was Emmanuel Serrano