GENETIC VARIABILITY OF SPONTANEOUS OUT-OF-SEASON OVULATORY ACTIVITY IN CHIOS SHEEP

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INTRODUCTION
Organising the breeding plan of a seasonally breeding species, such as sheep, presents a challenge to farmers and the industry as a whole, since both economical and biological considerations need to be carefully balanced. Avdi et al. (1993) studied the seasonality of Chios sheep breed in Greece and observed a relatively high proportion of ewes ovulating outside the normal breeding season. Recently, Hanocq et al. (1999) considered spontaneous, out-of-season ovulatory activity (SOA) as such trait and reported high heritability and repeatability estimates (0.37 and 0.20, respectively) for the Merinos d'Arles breed. The objective of this study was to examine variation sources of SOA in the Chios sheep breed.

MATERIALS AND METHODS
Animals and measurement of ovulatory activity. Ewes of the Chios breed that are kept at the Agricultural Research Station of Chalkidiki in Northern Greece (40°15′N) were studied. The reproductive season normally starts on May 21st and lasts until November. The onset of the season is marked by the introduction of males "ram effect". Mating is by natural service and lambing takes place between late October and April. SOA was determined by measuring the blood progesterone level (>1 ng/ml) in ewes by radioimmunoassay (Terqui and Thimonier, 1974) prior to introducing rams to the flock. Blood samples were taken twice at a 10-day interval in the beginning of May, for two consecutive years (1996 and 1997).

Data analysis. A total of 707 records of SOA from 435 ewes, daughters of 150 rams, were considered in the analysis. All available pedigree information was included and the total data set was for 1068 animals. In a preliminary analysis, age, live weight and month of previous lambing have been described as significant components of the variation of SOA (Kouttos, 2001). Three main fixed effects were defined for the genetic analysis. The first effect represented age and status of the ewe (7 levels: 1=young ewes that had never lambed before till 7=ewes that lambed for the 6th time in the previous season). The second effect represented live weight and had 6 levels (1=<50 kg, 2=50-54 kg, 3=55-59 kg, 4= 60-64 kg, 5=65-69 kg, 6=70 kg). The third effect was month of previous lambing and had 6 levels for October to February, and March and April combined. Two models were considered to estimate heritability and repeatability: a linear model using Average Information Restricted Maximum Likelihood (Gilmour et al. 1995, 1999) and a non-linear threshold model CMMAT2 (Misztal et al., 1989). For the non-linear threshold model, sires were required to have at least 2 daughters. All genetic relationships between sires were considered (total of 200 animals). Evidence for oligogenic inheritance was investigated by performing Structured Exploratory Data Analysis (SEDA-
Karlin et al., 1981) on estimated breeding values of individual animals from linear model. The tests that considered were: the Major Gene Index, the Offspring Between Parent function and the Mid-Parent Correlation Coefficient.

RESULTS AND DISCUSSION
On average, 29% of all ewes exhibited SOA, with no substantial variation between years (Table 1).

Table 1. Number of ewe records used in the analysis

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<thead>
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<th>1996</th>
<th>1997</th>
<th>overall</th>
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<tr>
<td>Number of ewe records</td>
<td>364</td>
<td>343</td>
<td>707</td>
</tr>
<tr>
<td>% of ewes showing spontaneous ovulatory activity</td>
<td>30.2</td>
<td>27.1</td>
<td>29.0</td>
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This result is very consistent with a study of the Merinos d’Arles breed (Hanocq et al., 1999) reporting 28% rate of SOA, determined in the same way. Of the 435 ewes considered, 272 had records in both years. About 16% of the latter exhibited SOA in both years, suggesting a possibly repeatable trait. It is also worth noting that of those ewes that showed ovulatory activity in the first year, 54% also showed activity in the second year. High proportion of ewes cycling out-of-season presents the opportunity to better manages the breeding period and reproduction of the flock. The significant (p<0.05) effect of ewe’s age, previous lambing month and live weight on SOA is shown in Figure 1. Older, heavier ewes, that had lambed early the previous autumn, exhibited more frequent activity. Similar observations were made from Hanocq et al. (1999). Heritability estimates were 0.216 (+0.084) with linear and 0.291 with threshold model. Threshold model estimate was higher than the linear model’s, in accordance with theory (Gianola, 1982) and the categorical nature of the trait. In the only other study of SOA as measured here, Hanocq et al. (1999) reported very similar heritability estimates for the Merinos d’Arles sheep breed. Linear model repeatability was 0.230 (+0.095). This value is very close to the heritability estimate obtained in the same analysis, indicating that the model did not distinguish very well between the residual and permanent environment effects. However, more than half of the ewes that exhibited SOA in the first year also exhibited it in the second, suggesting that the trait may indeed be repeatable. Results of the SEDA analysis are shown in Table 2. These tests may indicate a possible oligogenic inheritance in the population.

Table 2. Structured Exploratory Data Analysis results

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<tr>
<th>Test</th>
<th>Observed value</th>
<th>Theoretical value for oligogenic inheritance</th>
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<tr>
<td>Major Gene Index</td>
<td>0.854</td>
<td>&gt;1</td>
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<tr>
<td>Offspring Between Parent function</td>
<td>0.763</td>
<td>&gt;0.3</td>
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<tr>
<td>Mid-Parent Correlation Coefficient</td>
<td>0.889</td>
<td>0.6 -0.7</td>
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Figure 1. Effects of age (a), month of previous lambing (b) and live weight at estrus (c) on spontaneous out-of-season ovulatory activity (mean adjusted)
CONCLUSION
Spontaneous, out-of-season ovulatory activity, determined by blood progesterone levels, may be considered in the development of a breeding plan for the Chios sheep breed that would cater to the needs of the farmers and market demands. There appears to be considerable scope for selective breeding and genetic improvement for this trait. Further study is required to investigate the exact mode of inheritance and possible presence of major gene.

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REFERENCES