

FIRST DATA ON FEEDING ECOLOGY OF GOSHAWK *ACCIPITER GENTILIS* DURING THE BREEDING SEASON IN THE NATURA 2000 SITE DUNAS DE MIRA, GÂNDARA E GAFANHAS (BEIRA LITORAL, PORTUGAL)

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SUMMARY - *This study describes the diet of the Goshawk Accipiter gentilis within littoral ecosystems dominated by pine trees. Samples were collected during the breeding season of 2001 in Dunas de Mira, Gândara e Gafanhas, located in the littoral centre of Portugal and recently included in the Portuguese Natura 2000 network (PTCON 055). Diet composition was assessed from the analysis of 89 pellets and 154 prey remains, collected between the 15th of April and the 25th of July of 2001. Birds represented 86.6% of the total prey items. The remaining prey items were coleoptera (6.5%), mammals (3.6%) and reptiles (3.3%). In terms of biomass birds comprised 90.9%, followed by mammals (7.3%), reptiles (1.7%) and coleoptera (0.05%). Results show that this raptor has a predominantly ornithophagous diet. Domestic pigeon Columba livia var is the most important prey in this area both in terms of frequency and biomass (42.2% and 49.9%, respectively). During the breeding season the diet of the Goshawk is largely connected to Man.*

PRIMEIROS RESULTADOS SOBRE O REGIME ALIMENTAR DO AÇOR *ACCIPITER GENTILIS* NO SÍTIO DAS DUNAS DE MIRA, GÂNDARA E GAFANHAS, DURANTE O PERÍODO REPRODUTOR (BEIRA LITORAL, PORTUGAL). *Este trabalho pretendeu obter informação relativa à ecologia trófica do Açor Accipiter gentilis, de modo a tentar compreender o papel desempenhado por esta espécie de ave de rapina em ecossistemas litorais. O estudo decorreu durante a época de nidificação de 2001, na área do Sítio das "Dunas de Mira, Gândara e Gafanhas", recentemente incluído na Rede Natura 2000 (PTCON 055). A composição do regime alimentar foi estudada com base em 89 regurgitações e 153 restos de presas, recolhidas entre 15 de Abril e 25 de Julho de 2001. As aves representaram 86,6% do total de presas consumidas, os coleópteros 6,5%, os mamíferos 3,6% e os répteis 3,3%. Em termos de biomassa, as aves continuam a ter um papel predominante representando 90,9% da biomassa consumida, seguidas pelos mamíferos (7,3%), répteis (1,7%) e coleópteros (0,05%). Na área de estudo o Açor tem um comportamento alimentar predominantemente ornitófago, sendo o pombo doméstico Columba livia var a presa mais importante, tanto em termos numéricos como em biomassa (42,2% e 49,9%, respectivamente). Na base deste comportamento, estarão a elevada disponibilidade alimentar e uma maior vulnerabilidade à predação por parte desta espécie. Este regime alimentar do Açor durante o período reprodutor evidência uma clara dependência desta ave de rapina em relação a uma espécie estreitamente ligada ao homem.*

In Europe, the Goshawk *Accipiter gentilis* diet is relatively well studied (Opdam *et al.* 1977, Kenward 1978, Wikman & Tarsa 1980, Marquis & Newton 1982, Lindén & Wikman 1983, Goszczyński & Pilatowski 1986, Widén

1987, Manõsa 1994, Tornberg 1997). However, information about the feeding ecology of this species in Portugal is scarce and there are no studies focusing on this subject in particular. Therefore, the main goal of this study is to

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provide information on diet and feeding ecology of the Goshawk in order to clarify the role of this raptor within littoral ecosystems.

METHODS

The study area is located in “Dunas de Mira, Gândara e Gafanhas” in the littoral centre of Portugal (40°10'N–40°32'N; 8°42'W–8°55'W). This area was recently included in the Natura 2000 network (PTCON055), from Serra da Boa Viagem until Mata Nacional de Vagos (about 220 Km²). Serra da Boa Viagem, of a maximum altitude of 357 metres, is a calcareous geologic formation with steep and deep valleys. The rest of the area is characterised by sandy soil and a smoothly undulated surface, with altitude varying between sea level and 64 metres. According to Albuquerque (1954), this region has a Humid Mediterranean Climate. The main habitats include sand dunes, lagoons, streams, pine forest, scrublands, agriculture fields and a coastal mountain area. Sand dunes appear in 62% of the total area and Pine forest is the most representative habitat covering about 70% of the study area. This habitat contains almost exclusively Maritime pines *Pinus pinaster* with 14 to 80 years, within a heterogeneous structure of several storey patches, meadows, and scrublands. Apart from the Maritime pine there are also important patches of Umbrella pine *Pinus pinea*. In the understory, this species also occurs in a dispersed fashion along with the Firetree *Myrica faya* and Strawberry tree *Arbutus unedo*. In the vicinity of the lagoons and in drainage water lines, streams, ditches and humid dune slacks, several riparian species occur with the predominance of several species of Willow (*Salix alba*, *Salix repens* and *Salix arenaria*). In areas affected by forest fires and in some patches of adult pine stands there is a strong development of Acacia (mostly Sidney

golden wattle *Acacia longifolia* and Blackwood wattle *Acacia melanoxylon*). In some parts of the study area, there were well developed shrub patches within the pine stands. Agricultural fields are restricted to the eastern border of the area. Agriculture is semi-intensive, with a strong traditional component.

During 2001, 8-10 pairs of Goshawk were recorded in the study area, corresponding to 3.6-4.5 pairs/100 Km² (Petronilho *et al.* 2001). This is a high density when compared to 0.8-3.4 pairs/100 Km² in other regions of Portugal (Onofre *et al.* 1999).

Between the 15th of April and the 25th of July 2001, pellets and prey remains (feathers, bones and hair) were systematically collected on plucking sites and under nests. Coleoptera found in pellets were considered as Goshawk prey if encountered along with other granivorous prey items. Invertebrate items were excluded from the analysis if encountered in pellets containing insectivorous or omnivorous prey, considering that the latter might have ingested the first. Taking into consideration that the number of prey and the number of pellets were not significant nor equitably distributed by the different pairs (n=7), samples were analysed as part of only one lot, instead of performing an individual analysis or trying to assess its variation along time. Prey items found in pellets and prey remains were identified according to Teerink (1991), Brown *et al.* (1999) and with the help of reference collections compiled from the study area. In order to calculate values of ingested biomass, an average weight was established for each of the prey species according to the following authors: Snow & Perrins (1998a, 1998b) for bird species, MacDonald & Barret (1993) for mammals, and Mañosa (1994) for reptiles and Coleoptera. The weights attributed to the Wild rabbit *Oryctolagus cuniculus* and the Wood mouse *Apodemus sylvaticus* were obtained from individuals captured in the study area (Vingada,

Table 1. Diet composition of the goshawk *Accipiter gentilis* in the Natura 2000 network site “Dunas de Mira, Gândara e Gafanhas” during the 2001 breeding season (g = average biomass weight of each prey; N= number of consumed individuals; B = biomass in grams; * game species)

Tabela 1. Composição da dieta do Açor *Accipiter gentilis* no Sítio das Dunas de Mira, Gândara e Gafanhas durante a época de reprodução de 2001 (g=peso médio de cada presa; N=nº indivíduos consumidos; B=biomassa; *espécies cinegéticas).

Prey items	g	Prey remains	Pellets	Total	
				N	Biomass (g)
Insects		-	18 (14.52%)	18 (6.50%)	36 (0.05%)
Coleoptera	2	-	18 (14.52%)	18 (6.50%)	36 (0.05%)
Reptiles		7 (4.58%)	2 (1.61%)	9 (3.25%)	1182 (1.68%)
<i>Psammodromus algirus</i>	59	-	1 (0.81%)	1 (0.36%)	59 (0.08%)
<i>Lacerta lepida</i>	152	7 (4.58%)	-	7 (2.53%)	1064 (1.51%)
unidentif. Sauria	59	-	1 (0.81%)	1 (0.36%)	59 (0.08%)
Mammals		1 (0.65%)	9 (7.26%)	10 (3.61%)	5104 (7.25%)
<i>Crossidura suavelons</i>	8	-	1 (0.81%)	1 (0.36%)	8 (0.01%)
<i>Apodemus sylvaticus</i>	26	-	3 (2.42%)	3 (1.08%)	78 (0.11%)
<i>Rattus norvegicus</i>	398	-	1 (0.81%)	1 (0.36%)	398 (0.57%)
<i>Arvicola sapidus</i>	220	-	1 (0.81%)	1 (0.36%)	220 (0.31%)
<i>Oryctolagus cuniculus</i> *	1100	1 (0.65%)	3 (2.42%)	4 (1.44%)	4400 (6.25%)
Birds		145 (94.77%)	95 (76.61%)	240 (86.64%)	63,936 (90.87%)
<i>Gallinula chloropus</i> *	320	1 (0.65%)	1 (0.81%)	2 (0.72%)	640 (0.91%)
<i>Streptopelia turtur</i> *	140	2 (1.31%)	-	2 (0.72%)	280 (0.40%)
<i>Columba livia</i> var	300	101 (66.01%)	16 (12.90%)	117 (42.24%)	35,100 (49.89%)
<i>Columba palumbus</i> *	452	3 (1.96%)	-	3 (1.08%)	1356 (1.93%)
<i>Columba</i> sp.	376	-	44 (35.48%)	44 (15.88%)	16,544 (23.51%)
<i>Picus viridis</i>	185	2 (1.31%)	3 (2.42%)	5 (1.81%)	1483 (2.11%)
<i>Dendrocopos major</i>	85	1 (0.65%)	1 (0.81%)	2 (0.72%)	170 (0.24%)
<i>Erethacus rubecula</i>	17	1 (0.65%)	-	1 (0.36%)	17 (0.02%)
<i>Turdus merula</i> *	103	4 (2.61%)	-	4 (1.44%)	412 (0.59%)
<i>Turdus viscivorus</i> *	125	8 (5.22%)	13 (10.48%)	21 (7.58%)	2625 (3.73%)
<i>Parus major</i>	18	-	1 (0.81%)	1 (0.36%)	18 (0.03%)
<i>Garrulus glandarius</i> *	166	19 (12.42%)	5 (4.03%)	24 (8.66%)	3984 (5.66%)
<i>Pica pica</i> *	219	1 (0.65%)	4 (3.23%)	5 (1.81%)	1095 (1.56%)
<i>Fringilla coelebs</i>	24	2 (1.31%)	1 (0.81%)	3 (1.08%)	72 (0.10%)
unidentif. Passeriformes	40	-	6 (4.84%)	6 (2.17%)	240 (0.34%)
Total		153	124	277	70,358

unpublished data). The number of prey is presented as the minimal number of prey found in each pellet. Subsequently, these values were added to the number of prey collected nearby nesting sites.

RESULTS AND DISCUSSION

The results obtained from the analysis of 124 pellets and 153 prey remains are presented

in Table 1. Birds comprised 86.6% of the total of consumed prey, Coleoptera 6.5% (only two species *Hadrocarabus lusitanicus* and *Anoxia australis* were identified), mammals represent 3.6% and reptiles 3.3%. Among the 20 vertebrate species that were identified, the domestic pigeon *Columba livia* var was the most important prey both in terms of number of prey and biomass (42.2% and 49.9%, respectively). Other important vertebrate prey

Table 2. Contribution of game species to Goshawk diet in different European regions.**Tabela 2.** Contribuição das espécies cinegéticas para a dieta do Açor em diferentes regiões da Europa.

Geographic region	Total of consumed prey	Percentage of game species	Reference
Germany	4,825	66.68	Opdam <i>et al.</i> (1977)
Britain	838	48.81	Marquiss & Newton (1982)
Northeastern Spain	1,375	68.68	Mañosa (1994)
Dunas de Mira	294	23.40	present study

were Jay *Garrulus glandarius* (8.7%), Mistle Thrush *Turdus viscivorus* (7.6%) and Ocellated Lizard *Lacerta lepida* (2.6%). In terms of biomass, birds also represent a high proportion of consumed biomass (90.9%), followed by mammals (7.3%), reptiles (1.7%) and Coleoptera (0.05%). In terms of contribution to the ingested biomass the most important prey was the domestic pigeon, followed by wild rabbit *Oryctolagus cuniculus* (6.3%), the Jay (5.7%), the Mistle Thrush (3.7%) and the Green Woodpecker *Picus viridis* (2.1%).

In relation to the two methods used in this study (pellets and prey remains), a wider range of prey was identified from pellets. Some prey types such as Coleoptera, the Large Psammodromus *Psammodromus algirus*, Great Tit *Parus major* and four of the five mammal species, were detected exclusively by pellet analysis (see Table 1). Vegetal items consisting of Acacia leaf remains were also found in 48% of the pellets which were probably taken due to accidental ingestion during the consumption of prey on the soil or in the nest. This was previously recorded by López (1991) and Pereira & Medeiros (1996) for other raptors in similar studies.

This study enable to verify that:

1) the feeding behaviour of the Goshawk is dominantly ornithophagous. This is in agreement with results of other studies in Europe (Opdam *et al.* 1977, Marquiss & Newton 1982, Mañosa 1994, Tornberg 1997). Pigeons were the most important prey during

the breeding season. This is due to the high availability of domestic pigeons and their strong vulnerability to predation. There is a strong tradition of Columbophily in this region (about 6000 pigeons were estimated in 2001), which is also used regularly as a passageway by pigeons from other parts of the country between March and June, varying from 150,000 to 180,000 individuals per weekend (data supplied by *Federação Portuguesa de Columbofilia*). Exhausted pigeons are found frequently in trees or on the ground (pers. observ.). Domestic pigeons are unwary and lack fleeing strategies against wild predators. This study strongly suggests a clear dependence of the Goshawk upon species strictly connected to Man.

2) Game species, such as the Jay, the Mistle Thrush and the Wild rabbit, make 23.4% of the total number of prey. In spite of the fact that data refer to only one breeding season, it seems that the impact of this raptor on game species is significantly lower in this area, when compared with values obtained in other regions of Europe (Table 2). However, due to the small sample size, it is necessary to continue this study over a longer period in order to evaluate the real importance of these preys for the Goshawk.

3) In relation to the wild rabbit, it is noteworthy that its capture was low, when compared to other studies (Opdam *et al.* 1977, Marquiss & Newton 1982, Mañosa 1994). In fact, the number of harvested animals in the study area during the game season indicate a

density of 0.5 rabbits/ha (Eira *in prep.*). Estimates obtained from counts of faecal pellets along transects indicate an average annual density of 0.5 and 2 rabbits/ha in pine stands and scrublands, respectively. In some patches rabbit density can reach values higher than 5 rabbits/ha (Eira *in prep.*). The low rate of rabbit captures is probably related to the presence of other prey species that are easily captured by the Goshawk, such as the domestic pigeon, the Jay and the Mistle Thrush. Opdam *et al.* (1977) stated that the two latter species are not the best flyers among birds as commonly ascertained during fieldwork. Furthermore, predator avoidance strategies may also be implied in the low rate of wild rabbit captures. In this area, the wild rabbit takes refuge and is more active in dense habitats (scrublands) during daytime, while open areas are preferred at night (unpubl. data). Therefore, as already noticed by Villafuerte (1994) in Doñana, this strategy allows the rabbits to escape from aerial predators during daytime and from terrestrial predators during the night.

4) In spite of being the second most consumed prey item, Coleoptera represented only 0.05% of the total biomass. Nevertheless, the percentage of invertebrates detected in this study was relatively higher when compared to that obtained in similar studies in Europe (see Opdam *et al.* 1977 and Mañosa 1994). This may be explained by the fact that previous studies only considered insects that were found in the nests, and excluded those present in pellets.

5) Reptiles were present in the diet, which had already been registered throughout the Iberian Peninsula and only in some parts of Europe where this type of studies have been conducted (see Mañosa 1994). This latitudinal variation in the goshawk diet can be partially explained by the fact that the Ocellated Lizard and the Large *Psammotromus* are species which

distribution is limited to the Iberian Peninsula and the south of France (Arnold & Burton 1987). In relation to the Ocellated Lizard, its consumption might also be related with its relatively high local abundance (pers. observ.).

Finally, it is noteworthy that during the pellet analysis an insectivorous mammal species was identified for the first time in this region – the Lesser white toothed shrew *Crossidura suaveolens* – which is not listed in studies recently conducted by Vingada *et al.* (2000) and Petronilho (2001).

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REFERENCES

- Albuquerque, J.P.P. 1954. *Carta Ecológica de Portugal*, Direcção Geral dos Serviços Agrícolas, Lisboa.
- Arnold, E. N. & J. A. Burton 1987. *Guía de campo de los Reptiles y Anfibios de España y de Europa*. Ediciones Omega, S. A.. Barcelona.
- Brown, R., J. Ferguson, M. Lawrence & D. Lees 1999. *Tracks and Signs of the Birds of Britain and Europe*. Christopher Helm. A & C. Black. London.
- Eira, C. (*in prep.*) *Ecologia da raposa num ecossistema dunar. Uso de espaço e recursos alimentares*. Dissertação de Mestrado apresentada à Faculdade de Ciências e Tecnologia da Universidade de Coimbra.
- Goszczyński, J. & T. Pilatowski 1986. Diet of common buzzard (*Buteo buteo*) and goshawk

- (*Accipiter gentilis*) in the nestling period. *Ekologia Polska* 34: 655-667.
- Kenward, R.E. 1979. Winter predation by Goshawk in lowland Britain. *British Birds* 72: 64-73.
- Lindén, H. & Wikman 1983. Goshawk predation on Tetraonids: availability of prey and diet of the predator in the breeding season. *Journal of Animal Ecology* 52: 953-968.
- López, J.L.G. 1991. *El Aguilucho Lagunero Circus aeruginosus (L. 1748) en España. Situación, biología de la reproducción, alimentación y conservación*. ICONA, Madrid.
- Macdonald, D. & P. Barret 1993. *Mammals of Britain and Europe*. Collins Field Guide. Harper-Collins Publishers.
- Mañosa, S. 1994. Goshawk diet in the Mediterranean area of Northeastern Spain. *Journal of Raptors Research* 28: 84-92.
- Marquiss, M. & I. Newton 1982. The Goshawk in Britain. *British Birds* 75: 243-260.
- Onofre, N., M. Capelo, P. Faria, F. Teixeira, P. Cortez, H. Blanco, V. Condeço, C. Cruz, A. Pinheiro, G. Rosa, J. Claro, D. Venade, J. Almeida, M. Pais, J. Safara, R. Cangarato, C. Peça & D. Pereira 1999. Estimativas de abundância de aves de rapina diurnas em habitats florestais e agrícolas em Portugal Continental in Beja, P., P. Catry & F. Moreira (Eds.). *Actas do II Congresso de Ornitologia da Sociedade Portuguesa para o Estudo das Aves*. SPEA. Lisboa: 177-179.
- Opdam, P., J. Thissen, P. Verschuren & G. Muskens 1977. Feeding ecology of a population of Goshawk *Accipiter gentillis*. *Journal für Ornithologie* 118:35-51.
- Pereira, A.C. & F.M. Medeiros 1996. Introdução ao estudo do comportamento alimentar de *Buteo buteo rothchildi* no Arquipélago dos Açores in Farinha, J.C., J. Almeida & H. Costa (Eds.). *I Congresso de Ornitologia da Sociedade Portuguesa para o Estudo das Aves*. SPEA. Vila Nova de Cerveira: 50-52.
- Petronilho, J.M.S., J.P. Calisto, L. Cerqueira, M. Ferreira, C. Eira & J. Vingada 2001. *Programa de monitorização de avifauna no Sítio Dumas de Mira*. Relatório de Progresso não publicado, 19pp.
- Petronilho, J.M.S. 2001. *A Fauna do Concelho de Mira*. Câmara Municipal de Mira.
- Snow, D.W. & C.M. Perrins (Eds.) 1998a. *The Birds of the Western Palearctic*. Concise edition. Volume I. Non Passerines. Oxford University Press, Oxford.
- Snow, D.W. & C.M. Perrins (Eds.) 1998b. *The Birds of the Western Palearctic*. Concise edition. Volume II. Passerines. Oxford University Press, Oxford.
- Teerink, B.J. 1991. *Hair of West-European Mammals*. Cambridge University Press.
- Villafuerte, R. 1994. *Riesgo de predación y estrategias defensivas del Conejo Oryctolagus cuniculus, en el Parque Nacional de Doñana*. Trabajo para optar al grado de Doctor en Biología. Departamento de Biología Animal. Universidad de Cordoba.
- Vingada, J.V., C. Eira, J. Cancela & A.M.V.M. Soares 2000. *Costa de Quiaios-Mira. An important area to preserve*. LIFE – RECOGNIZE (Study to protect) Recovery, Conservation and Management of Species and Natural Habitat in the Centre-Litoral Region of Portugal. Dissemination report.
- Widén, P. 1987. Goshawk predation during winter, spring and summer in boreal forest area of central Sweden. *Holarctic Ecology* 10: 1-7.
- Wikman, M. & V. Tarsa 1980. Food habits of the goshawk during the breeding season in southwestern Finland 1969-77. *Suomi Riista* 28: 86-96.