The Diet of three Black Redstarts *Phoenicurus ochruros* wintering at Mdina

Martin A. Thake

The droppings of three Black Redstarts *Phoenicurus ochruros* wintering at Mdina, Malta, were investigated in order to determine the components of the birds' diet. Visual observations of the birds' behaviour were also made.

The droppings of an adult male were collected from beneath one of its habitual perches, while the droppings of two different females were collected from beneath their common roost. The male's droppings represent food taken at various times of day during daylight, whereas the females' droppings represent food taken in the early morning and late afternoon.

The droppings were placed in alcohol and dissected under a binocular microscope (x 15). The contents of each (numbered) dropping were noted separately.

Droppings were collected during the birds' wintering period between late October and early March of the 1996-97 winter. 21 male and 106 female droppings were examined. The two females roosted in close proximity to one another and, as their droppings could not be distinguished, they were analysed together.

Results

Fruit was the predominant item in the females' droppings. This feature was evident in every month of analysis. As these droppings represent early morning and late afternoon feeding, it seems likely that fruit was eaten preferentially at such times. *Washingtonia filifera* drupes were the most important items in the dawn/dusk diet. This remained the case long after all the drupes had disappeared from the palm tree in early December, as the two females continued to visit the ground below the palm tree to take fallen drupes well into March. The palm tree was in the male Black redstart's territory (see Fig. 1 and Table 1). Ants and beetles were the commonest invertebrates taken by the females (se Table 2). Up to 4 slug shells were
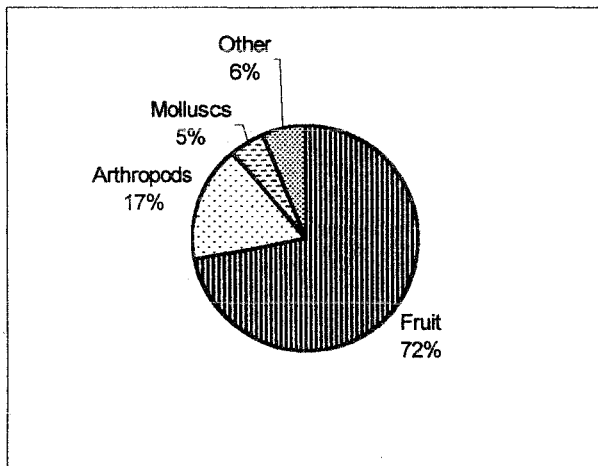

Fig. 1. Average composition of 106 droppings produced by two females Black Redstarts.
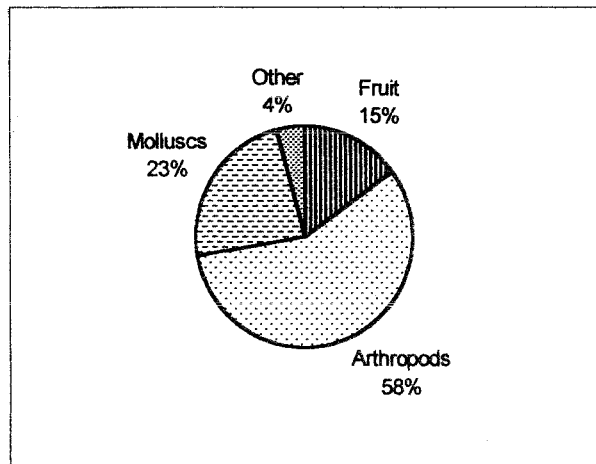

Fig. 2. Average composition of 21 droppings produced by a male Black Redstart. The composition of these droppings differs significantly from that of the females' droppings (G - test; p < .001).

found in a single dropping. Droppings which contained nothing but slug remains were uncharacteristic – a greyish shapeless smudge within a droplet of liquid. Droppings consisting of the remains of *Lonicera* fruits were also shapeless and uncharacteristic.

The male bird's droppings refer to various times of the day. Fruit was much less abundant in these droppings, figuring prominently only while the *Washingtonia filifera* bore fruit (see Fig. 2 and Table 3). Invertebrates predominated in

Month	Fruit %	Arthropods %	Molluscs %
early November	77.8	18.5	3.7
late November	56.2	37.5	6.2
early December	63.3	26.7	6.7
late December	64.7	17.6	11.8
early January	66.7	33.3	0
late January	72.2	16.7	5.6
early February	62.5	37.5	0
late February	95.8	4.2	0
early March	76.5	8.8	2.9

Table 1. Estimates of the proportion of various food types in the diet by month of year, estimated by volume of 'item' in faeces.

the male's droppings. One dropping contained part of the maxilla of a frog *Discoglossus pictus*, hitherto unrecorded in the diet of this species (Cramp *et al.* 1988).

This study corroborates earlier work on the diet of the Black Redstart (see review in Cramp *et al.* 1988) in that ants and other ground dwelling invertebrates were an important part of the diet for much of the day. The large *Diptera* were taken in aerial pursuit, which has also been recorded previously. Predominance of fruit among food items has not been reported previously.

Acknowledgements

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Item	Identified in n droppings
Washingtonia filifera fruits	66
Solanum luteum fruits	15
Lonicera japponica fruits	10
Hedera helix fruits	1
Unidentified fruit	12
grass leaves	4
moss leaves	3
springtail (*Collembola*)	1
termites (*Isoptera*)	2
Curculionid beetles	1
Straphylinid beetles	5
other beetles (*Coleoptera*)	13
adult *Lepidoptera*	1
ants (*Hymenoptera*)	19
large *Diptera*	7
small *Diptera*	1
Arachnida	1
Isopoda	6
unidentified arthropod remains (incl. some centipedes & spiders?)	27
snails (*Mollusca*)	9
slugs (*Mollusca*)	7
ovarian discharge	1

Table 2. Items identified in the droppings of two female Black Redstarts (total: 106 droppings).

Item	Identified in n droppings
Washingtonia filifera fruits	6
Solanum luteum fruits	2
Lonicera japponica fruits	1
grass leaf	1
springtail (*Collembola*)	1
cockroach (*Blattodea*)	1
Curculionid beetles	2
Straphylinid beetles	1
other beetles (*Coleoptera*)	13
Lepidoptera larva	1
ants (*Hymenoptera*)	9
large *Diptera*	5
Arachnida	1
Isopoda	2
unidentified arthropod remains (incl. some centipedes & spiders?)	11
Frog (probably a small *Discoglossus pictus*)	1
snails (*Mollusca*)	6
slugs (*Mollusca*)	3

Table 3. Items identified in the droppings of a male Black Redstart (total: 21 droppings).

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A note on aging and sexing Common Chiffchaffs *Phylloscopus collybita* using wing morphometrics

Charles Galea Bonavia & Charles Gauci

Abstract
We use multivariate and univariate techniques to investigate sexing and aging of Common Chiffchaffs using wing morphometrics. We show that the wing length is an adequate metric to sex but not to age Common Chiffchaffs *Phylloscopus collybita.*

Introduction
The Common Chiffchaff *Phylloscopus collybita* cannot be assigned in the field to a particular age/sex class on plumage characters (Svennson 1992) but as it is sexually partly dimorphic in wing-length (see Snow and Perrins 1998,Ticehurst 1938, Williamson 1976) and juveniles have shorter wings than adults (see e.g. Norman 1997, Tiainen and Hanski 1985), we investigated whether wing morphometrics can be used in sexing and aging birds. In this paper we show that wing length, an easily taken and commonly used size index, is adequate for the first but not for the second purpose, at least for the Common Chiffchaffs that occur as autumn /spring passage migrants and as winter visitors in the Maltese Islands (for more details on status see Sultana and Gauci 1982).

Materials and Methods
A sample of 138 Common Chiffchaffs caught during ringing sessions at Buskett, Ghadira, and Wied il-Marg, was measured for wing length to the nearest 0.5 mm, for lengths of primaries 2-9 (abbreviated as p1-p8) to the nearest 0.5 mm and wingspan to the nearest mm. Not all measurements were taken for each bird. Further details of the sampling protocol can be found in Galea Bonavia and Gauci (Galea Bonavia and Gauci this volume pp 16-19).

We analysed only birds referable to *P. c. collybita* but we included also five birds assigned to a sub-population with highly rounded wings (see Galea Bonavia and Gauci this volume). Birds were assigned to two age classes: age class 2, unaged birds and age class 4, adults, according to the criteria adopted by Galea Bonavia and Gauci (Galea Bonavia and Gauci this volume). One bird, ring number 3H091, was measured both as unaged (age class 2) and two years later as an adult (age class 4). Both sets of measurements have been included in our analysis.

An index of the linear dimensions (medial-distal) of the proximal skeletal elements (radius/ulna x2, humerus x2) of the wings was calculated by subtracting the wing length multiplied by two from the wingspan (this would also include sternal width).
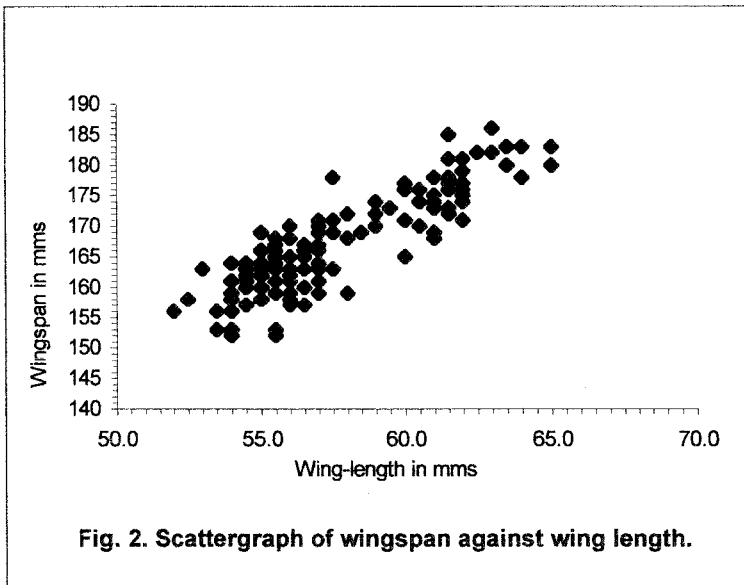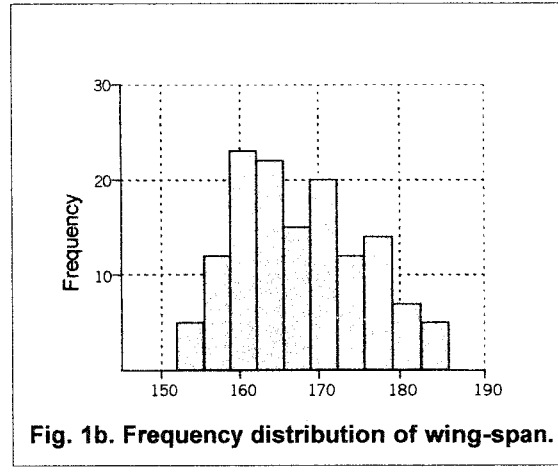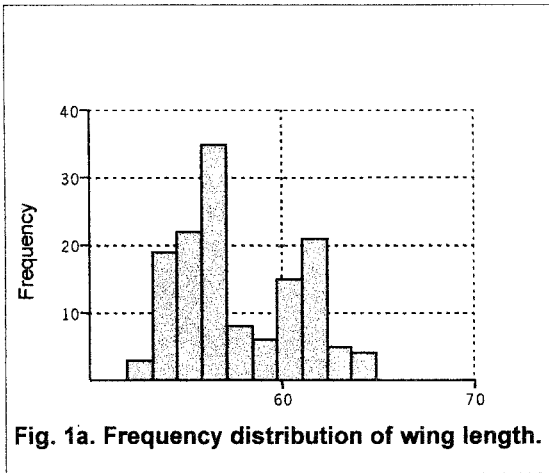
Statistical Procedures
P.C.A. was used to analyse primary lengths while the distributions of wing length and wingspan and their relationship were determined graphically. Wingspan and wing length were tested for normality and where appropriate parametric/non-parametric tests were used in correlations and comparisons. Variates were log transformed where necessary using natural logarithms. We used PAST statistical package (Hammer *et al.* 2001) and Microsoft Excel (Microsoft 2000).

Results
The frequency distributions of wingspan and wing length do not differ (Kolomogorov Smirnoff test, D=1, *p* (same) = 1), both having a bi-modal distribution though wing length is more clearly so (fig 1a and fig 1b). This is to be expected as wingspan and wing length are extremely highly correlated (Spearman's Rho 0.85272, *p*=0).

A scatter graph of these two variates, with wing length plotted on the x-axis and wingspan on the y-axis, shows two well defined clusters, better separated along the x-axis i.e. wing length, than along the y-axis i. e. wingspan, with only a single uncertain data point.

Fig. 1a. Frequency distribution of wing length.

Fig. 1b. Frequency distribution of wing-span.

Fig. 2. Scattergraph of wingspan against wing length.

Fig. 3. PCA biplot: square = 3H091, crosses = adults (age class 4), black dots = unaged (age class 2).

A plot of P.C.2 against P.C.1 (see table 1) of the log-transformed primary lengths (Fig. 3), also clearly shows a two-cluster pattern, with the points separated along the first component axis, which summarises size but not along the second component, which summarises shape (but see Lockwood et al. 1998). In other words the ordination has separated the sample on size but not on shape. The net difference between these two clusters is further emphasised by the minimum spanning tree, which joins points within clusters but not across clusters. Significantly, the adult sample is split between the two clusters while interestingly both sets of measurements of 3H091 plot within the same cluster. Of course it is entirely possible that 3H091 was first measured when already an adult but the shorter wingspan and wing-length of the first set compared to the second set indicate that it was a juvenile rather than an adult when first measured.
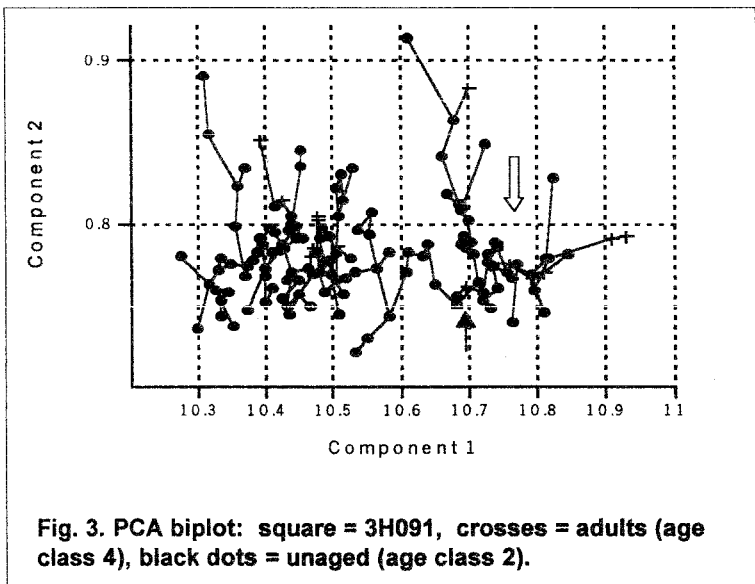
The first, larger cluster identified by the P.C.A. is composed of individuals having wing lengths of 52-59 mm, with only two exceptions at 60mm and 61 mm. The second, smaller cluster is composed of birds having wing lengths between 59.5 mm and 64 mm, also with two exceptions, at 57.5 and 59 mm. Such a close correspondence between the results of the scatter graph and of the P.C.A. is only partly to be expected because though the wingspan and wing length obviously are not independent of primary length, the wingspan at least contains additionally skeletal elements, which only weakly though significantly correlate with primary lengths (Spearman's Rho = 0.21772-0.27623, p=0.010892-0.0011332). Thus the scatter graph provides further support for the evidence offered by the P.C.A. ordination. However it should be noted that in the scattergraph there is no evidence for any sub-clustering in contrast to the PC.A. which in the first, larger cluster shows slight evidence of two sub-clusters.

Discussion

Separation into the four possible age/sex classes-juvenile i.e. juvenile males, juvenile females, adult males, adult females, would require four clusters rather than the two, possibly 3, identified by the scattergraph, the histograms and the

	P.C.1	P.C 2
variance explained	93.72	2.8535
Factor loadings		
primary 1	0.3453	-0.864
primary 2	0.3547	-0.2022
primary 3	0.3617	0.0544
primary 4	0.3903	0.1451
primary 5	0.3654	0.2391
primary 6	0.3464	0.218
primary 7	0.3221	0.2291
primary 8	0.3152	0.1774

Table 1. P.C.A. of the primary lengths.

P.C.A. biplot. This raises the question of which category the analysis has identified-sex or age?

We hypothesise that it is the sex-class rather than the age-class that has been identified. This is demonstrated in the P.C.A. biplot by the splitting of the adult sub-sample between the two clusters and the plotting of both sets of measurements of 3H091 within the same cluster (but see above). If it were the age-class that had been identified it would be expected that the adults would plot in the same cluster while one set of measurements of 3H091 would plot in one cluster, the second set in the other cluster.

The indication of the sub-division of the first cluster into two sub-clusters points towards a further separation of this cluster into the two age-classes but a larger sample is required to show and identify any age-specific differences clearly.

Thus both the P.C.A. and the scattergraph clusters are composed of the same wing lengths with just four exceptions; there is a highly significant difference (t-test, $t = -19.221$, $p < 0.05$) between the wing lengths identified by the two clusters. Our result is in agreement with that obtained by Tiainen and Hanski (1985). Thus wing length is a reliable metric to use to sex but not age an individual bird. More generally we infer that the wing shape of males and females does not differ and that the difference in wing length and wing-span between juveniles and adults is swamped by a greater sex-specific difference. It is interesting to note that the only trace of separation according to age occurs in the females, contrary to Hanski and Tiainen (1985) who found a greater difference in wing length between adult and juvenile males than between adult and juvenile females though presumably their study refers to *P. c. abietinus*.

In conclusion we suggest that birds with wing length values of up to 58mm can be safely sexed as females, from 59.5mm to 65mm as males. We also suggest that values of 58.5mm and of 59 mm cannot be used for sexing. It should be noted that these values apply solely to *P. c. collybita* and possibly to the birds that occur in the Islands but considering that recoveries of Common Chiffchaffs, both of birds ringed locally and recovered abroad and ringed abroad and recovered locally, have come from a wide area in Europe (see e. g. Sultana and Gauci 1989, 1990-1991), our results may apply on a wider scale. We need hardly add that of course care has to be taken that the primaries composing the wing tip are not abraded.

Acknowledgements

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Prey of a Peregrine *Falco Peregrinus* Pair off Crete

Harald Pieper & Dietrich Ristow

The diet of the Peregrine *Falco peregrinus* has been well studied in various parts of Europe (e.g. Becker 1998, Glutz *et al.* 1971, Langgemach *et al.* 1997, Oro & Tella 1995, Ratcliffe 1993, Rockenbauch 2000), but there are no previously published data from Greece. Peregrines in Greece live to a large extent on small islands of the Aegean (Handrinos & Akriotis 1997) where local bird populations are too low in numbers to provide the food base for this falcon.

What do Peregrines prey upon at such isolated sites? In the context of other studies, we had the opportunity to obtain some data on this question. The material presented here was collected on a 30 ha. island situated more than 20 km off Crete and with limestone cliffs reaching 120 m height. The abundance of breeding birds is given in Table 1. Although on this islet there is a substantial bird population, the three species present in appreciable numbers are atypical prey species because of their size. So the question remains valid for the study island.

Breeding species	Number of pairs
Puffinus yelkouan	3
Calonectris d. diomedea	700
Phalacrocorax aristotelis desmarestii	1
Falco peregrinus	1
Falco eleonorae	300
Larus cachinnans	100
Columba livia	10
Monticola solitarius	1

Table 1. Abundance of breeding birds on the study islet off Crete. (In addition to breeding birds, there may be visiting up to half a dozen Audouin's Gulls *Larus audouinii*, one or two Kestrels *Falco tinnunculus* from a neighbouring islet and a straggling Grey Heron *Ardea cinerea*, the latter two species feeding upon lizards *Podarcis erhardii*. All other birds seen were resting or passing migrants in spring and autumn).

Year	No. of fledglings
1989	1
1990	1
1991	1
1992	1
1993	-
1994	-
1995	3
1996	2
1997	2
1998	<1
1999	2
2000	-

Table 2. Peregrine success on the islet off Crete.

After the breeding season of the Peregrine, this islet was visited for 2-7 weeks in June-October each year to study Cory's Shearwater *Calonectris diomedea* and Eleonora's Falcon *Falco eleonorae*. During the course of this work, the Peregrine pair or their fledglings were seen on several days each time, although less than a fifth as often as in July-October. Direct pursuit of prey was never observed. Four alternative sites for the eyrie were located. Whilst the nests of Eleonora's Falcon typically lie on slopes in small corners with partial shade (Wink *et al.* 1982), the four Peregrine nests were in large and more than 1.5 m-deep caves in the vertical cliffs with complete shade all day. Each nest was used for several consecutive years.

When checked, the young had already fledged (Table 2) and the wind had blown the prey feathers away so that only bones were collected for analysis (Table 3 column A). As the gulls fledge in June, the Levantine Shearwaters in July/August, and the Eleonora's Falcons as well as Cory's Shearwaters in October, respectively, such bones must be from adults. Pluckings were collected from perches which were identified by means of Peregrine moult feathers so that confusion with prey of Eleonora's Falcon was avoided (Table 3 column B).

Due to the collection procedure, pluckings refer to the time after fledging. Prey items listed are values for each species. There is a preferential bias for finding and collecting large prey items (see also Langgemach *et al.* 1997). This way, especially in column A, the data is distorted in favour of the breeding species of the island. This is obvious when estimating the biomass. Depending on the values assumed, there is total of about 50 kg in

Prey Species	Number of prey Items			Prey Species	Number of prey Items			Prey Species	Number of prey Items		
	A	B	C		A	B	C		A	B	C
Puffinus yelkouan (ad.)	19	1		Larus ridibundus		1		Lanius minor		3	
Calonectris diomedea (ad.)	19		7	Larus minutus		2		Lanius senator		4	
Phalacrocorax aristotelis (juv.)		1		Sterna hirundo	1	1		Lanius collurio		2	
Ixobrychus minutus	1	7		Chlydonias leucopterus	1	1		Hippolais icterina		2	
Botaurus stellaris	1			Chlydonias hybridus		2		Phylloscopus trochilus		6	
Anas querquedula	1			Columba livia	17	2		Phyloscopus sibilatrix		2	
Falco eleonorae (ad)	5		5	Streptopelia decaocto		1		Muscicapa striata		9	
Falco naumanni	1			Streptopelia turtur	12	19		Ficedula hypoleuca		2	
Coturnix coturnix	1	3		Clamator glandarius		1		Ficedula albicollis		1	
Porzana parva	2	1		Cuculus canorus		10		Saxicola torquata		1	
Gallinula chloropus	2			Otus scops		1		Oenanthe oenanthe		3	
Charadrius dubius		1		Caprimulgus europaeus	1	2		Phoenicurus phoenicurus		3	
Calidris minuta	1			Apus apus		2		Turdus merula		1	
Calidris ferruginea	2	1		Merops apiaster	1	2		Turdus pilaris		1	
Calidris alpina		1		Coracias garrulus		3		Turdus philomelos		3	
Philomachus pugnax	2	5		Upupa epops		23		Fringilla coelebs		4	
Gallinago media		1		Calandrella brachydactyla		2		Emberiza melanocephala		1	
Gallinago gallinago	1	1		Galerida cristata		1		Passer domesticus/ hispaniolensis		2	
Tringa stagnatilis	1	1		Hirundo rustica		4		Sturnus roseus/vulgaris		1	
Tringa nebularia	2			Delichon urbica		4		Oriolus oriolus		12	
Tringa ochropus	1	2		Riparia riparia		4		Corvus monedula	1		
Tringa glareola		1		Anthus trivialis/cervinus		7		Passeriformes spp.	ca. 40		
Larus cachinnans (ad.)	26			Anthus campestris		3					
Larus cachinnans (fledgling)			5	Motacilla flava		1					

Prey Species	Number	of prey	Items
	A	B	C
Total	ca. 168	180	17

Table 3. Peregrine prey from the study islet off Crete, collected June-September. A: Prey determined from old bones which were obtained at four eyries. B: relatively fresh pluckings collected at perch sites. C: Typical number of carcass specimen per year found in the rest of the whole island.

column A, i.e. about five times as much as in column B. If we take 100 g of biomass as daily food for a Peregrine, there would be 35 kg of biomass for a year; so the total of column A would be above and that of column B below this value. This distortion of data towards large prey would even be greater if corpses of prey from the local colonies which were found away from the favourite perches, were simply included in Column B. As the total in column A or B resembles roughly a year's diet for a Peregrine, the number of prey corpses from the local colonies is given as a typical value per year (Table 3 Column C), so that at least a coarse comparison between columns A, B, and C is allowed. Care was taken for specimen of Column C to avoid confusion with other causes of death and possible later decomposition by rats Rattus r. alexandrinus. It is worthwhile to draw attention to some specific points in Table 3.

(a) The extent of exploitation of the three colonial breeding species of the islet is quite low in comparison to the large number available so near the eyrie. This low percentage in case of Eleonora's Falcon and Yellow-legged Gull might be explained by a communal defense reaction of these species, but such an explanation cannot be put forward for Cory's Shearwater. After the Peregine young have left the eyrie, there is a tendency to prefer gull fledglings which become available in June. Fledglings of the other two species would become available in October,

and we do not have evidence to which extent they might be exploited. Amongst the Cory's Shearwaters there were one at least 9 year, and two at least 11 year old birds; and amongst the Eleonora's Falcons there were one fledgling, one 3 year, one 10 year and one 11 year old bird (as determined from the rings they wore).

(b) Although the Levantine Shearwater is the more nocturnal of the two shearwater species on the islet, it bears higher predatory by Peregrines. It is the smaller species. Neither come close to shore in the daytime. At sunset on windless days, Cory's Shearwaters regularly form a raft of 50 to 1200 birds about 1-2 km from the islet, but no attack on these flying or swimming birds was observed. In daylight, the Levantine Shearwaters are only seen as single birds, foraging more than 1 km from the islet, rarely in groups of 3-10 birds passing straight fast to the feeding grounds, or as 2-4 individuals rafting with the Cory's Shearwaters. The prey numbers found exceed numbers of local breeders plus prospectors and thus suggest that Levantine Shearwaters are chased at sea and not close to the cliffs.

(c) The variety of the prey species suggest that Peregrines prefer to prey upon solitary flying, migrating birds above the sea rather than attacking birds close to the cliffs or on the islet. Due to the season of sampling, there are more such migrants in column B than in A (compare for example *Ixobrychos minutus*, *Cuculus canorus*, *Upupa epops* or the ratio of *Streptopelia turtur* as compared to *Columba* livia).

(d) Of course, the average prey size is larger than that of the Eleonora's Falcon. For this medium-sized falcon more than 100 prey species have been identified from the same site (Ristow *et al.* 1986); prey size above 70 g such as a Hoopoe *Upupa epops* are exceptional and waders make up only 0.034 % of prey. For the Peregrine, the percentage of this group is 6.0 % (column A) or 7.3 % (column B).

(e) The Collared Dove's *Streptopelia decaocto* nearest breeding sites are 25 and 55 km away, those of the Jackdaw *Corvus monedula* 45 and 50 km (Scharlau 1999). It is virtually impossible that such prey was carried over such a distance. Are then, amongst the other prey, many more individuals dispersing as non-breeders to the islet?

(f) A total of 157 bird species are known for the archipelago (Ristow & Wink 1995). Six new species were recorded in this study (*Botaurus stellaris, Anas querquedula, Tringa nebularia, Streptopelia decaocto, Turdus pilaris, Corvus mondeula*).

(g) The total of 67 prey species in this study closely matches a report of 70 prey species with 341 items for three islands south of Marseille /France (Kayser & Bayle pers. comm.). The ratio of Non-Passeriform prey items is 76 % (column A) and 51 % (Column B) off Crete and only 31 % off Marseille, but the bias towards large prey in the Cretan data impairs the assertion. In any case no shearwaters, Yellow-legged Gulls, or raptors were found in that study, although they are present there, and both shearwater species and Yellow-legged Gulls were identified in the diet of the Eagle Owl *Bubo bubo* on these small islands (Vidal & Bayle 1997).

We conclude that for an isolated island Peregrine pair, they prey upon spring migrants in the first place and can supplement their diet by atypical large prey if it is available near the eyrie. The importance of dispersing birds as prey needs clarification. After disbanding of the family, a sole individual may remain who feeds on autumn migrants. The distance from which prey is carried to the eyrie needs further investigation, especially over which distance shearwaters are carried.

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