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The diet of the Dipper *Cinclus cinclus* as represented by faecal and regurgitate pellets: a comparison

ALISON J. TAYLOR *and* JOHN O'HALLORAN* *Department of Zoology and Animal Ecology, University College Cork, Lee Maltings, Prospect Row, Cork, Ireland*

The diet of the Dipper Cinclus cinclus *was assessed by analysis of faecal and regurgitate pellets at six sites in southwest Ireland during the winter, summer and autumn of 1991 and 1992. In total 210 faecal and 210 regurgitate pellets were collected, containing the remains of 1648 and 1655 prey items, respectively. There was no significant difference in the taxonomic composition of the diet as represented by the two pellet types, i.e. no taxon was under- or over-represented in either pellet type. There were few differences between prey sizes in the faecal and regurgitate pellets from the same site and sampling time. Where significant differences were found, the absolute difference between the medians was small and it was the faecal sample which had the larger median prey size. There was no evidence that Dippers use regurgitates to eject the remains of large prey.*

Identification of prey remains in faecal samples has become a common method of dietary analysis in studies of invertebrate-feeding birds (e.g. refs 1–6). In addition to faecal pellets some of these birds also produce regurgitated pellets. Davies compared the faecal and regurgitate pellets of Spotted Flycatchers *Muscicapa striata* and found that the mean lengths of prey remains in the regurgitates were greater than those in the faecal pellets.[2] He concluded that flycatchers use regurgitate pellets to eject the remains of large prey. The diet of the Dipper *Cinclus cinclus* has been investigated by faecal analysis and is reviewed by Tyler and Ormerod.[7] Dippers also produce regurgitate pellets. Ormerod and Tyler reported a comparison of taxonomic composition for these two pellet types, collected in winter, without any estimates of prey size.[4] If, as in Spotted Flycatchers, Dippers use regurgitates to eject the remains of their larger prey, any study of prey size or taxonomic selection in this species may be biased when based on faecal analysis alone. This study compared the taxonomic composition of, and prey size in, the diet of the Dipper as represented in faecal and regurgitate pellets. It is not the aim of this paper to describe temporal and spatial variation in Dipper diet; such questions will be addressed elsewhere.

*Correspondence author.
Email: johalloran@ucc.ie

METHODS

Study sites

The study area, in southwest Ireland, is described in detail in Smiddy *et al.*[8] This study included two sites on the River Araglin (here denoted Araglin B and Araglin C), two on the River Douglas (Douglas B and Douglas C), one on the Glashaboy (Glashaboy C), all in County Cork; and one on the River Licky (Licky), in County Waterford. Pellets deposited on emergent rocks in the river were collected from these sites during January 1991, July 1991, November 1991, January 1992, July 1992 and October 1992 (except Douglas B which was not sampled in January 1991). Dippers were territorial throughout the year at these sites (pers. obs.; see also Tyler & Ormerod[7]); each site comprised one pair's territory. Pellets were likely to be those of adult birds in January and October/November, but may also have

included those of juveniles in July. Six faecal and six regurgitate pellets were collected from each site in each time period.

Treatment of samples

Pellets were preserved individually on site in 70% ethanol and subsequently deflocculated overnight in 0.5M NaOH before examination at a magnification of ×40–80 (after Ormerod[3]). A subsample (five slides per sample) of each pellet was examined at a higher magnification (×400) for worm chaetae, but none was found. Prey remains were identified to the taxonomic groups, usually family or order, shown in Appendixes 1 & 2. Prey were counted on the basis of mandibles (freshwater insect larvae and nymphs, adult coleopterans), gnathopods (Gammaridae), shell spires (gastropods) and head capsules or wings (adult insects with freshwater larvae or nymphs, terrestrial insects).

The mass (mg) of each prey item in the diet was estimated. For taxa with significant temporal and/or spatial variation in size (tested by unbalanced multifactor ANOVA, general linear model), the mass of individual prey in the diet was estimated using regressions of dry mass on mandibular length (Appendix 1). Insects used to produce these regressions were collected from the rivers in this study area and freshly frozen until required. The length of the right mandible of each individual was measured with an ocular micrometer (to the nearest 0.025 mm) and then these insects were individually freeze-dried and weighed. For all other taxa an annual (or seasonal for Gammaridae) mean dry mass was determined (Appendix 2).

Data analysis

Dietary data were converted to percentage contribution by number of each taxon. The proportion of each prey category was determined separately for each faecal (or regurgitate) pellet. Diet composition was then presented as the average of the proportions of each taxon in the six individual pellets, i.e. the data were not pooled (after Wallace[9]). This reduces the problem of a pellet with an unusually high number of a particular taxon biasing the estimate of diet composition.

The procedure was carried out on the faecal and regurgitate pellets from each site and time period. This resulted in 35 faecal 'samples' (each 'sample' comprising the average of six pellets), each with a corresponding regurgitate 'sample' (also comprising the average of six pellets). These diet samples were subjected to a divisive, hierarchical, dichotomous, polythetic classification (TWINSPAN).[10] To transform the quantitative diet data into the qualitative data required for this analysis, each taxon and its percentage contribution was transformed into a single unit called a pseudo-species.[11,12] 'Cut-levels' are used to define pseudo-species. In this study six cut-levels were employed (level 1 = 5%, 2 = 10%, 3 = 20%, 4 = 30%, 5 = 40%, 6 = 50%), for example, pseudo-species Simuliidae2 refers to a cell in the original data matrix which corresponds to a value of >10% Simuliidae. A taxon with a high percentage value is included in the analysis both at the appropriate pseudo-species percentage level, e.g. Simuliidae3, and at all lower levels, i.e. Simuliidae1 and Simuliidae2.

This method retains more of the information contained in the original quantitative data than does the use of simple presence/absence categories. TWINSPAN produces a dichotomous hierarchy of clusters in which members of a cluster at each level are more similar to each other in their pseudo-species composition than to samples in other clusters.[a] If the faecal sample and corresponding regurgitate sample from the same site and time period are more similar to each other than to any other faecal or regurgitate samples, then one would expect the two samples to be paired in final clusters.

Overall similarity in diet according to faecal and regurgitate samples was also investigated by correlating the percentage contribution by number of each taxon in the faecal sample with the percentage contribution in the corresponding regurgitate sample. Data from all taxa at all sites within each time period were pooled to ensure sufficient sample size and the percentage data were squareroot arcsine transformed to allow parametric correlation.

To investigate whether any taxa were under- or over-represented in either the faecal or regurgitate samples, the percentage contribution of each taxon was compared with a Wilcoxon matched pairs test. Data from all sites, months and years were pooled to ensure

sufficient data for testing and the median percentage contribution of each taxon to the faecal and regurgitate samples was examined.

Prey size, pooled for all taxa, was analysed by unbalanced multifactor ANOVA (general linear model) with site, month, year and pellet type as factors. November (in 1991) and October (in 1992) were coded as the same month in this analysis. To test for a difference in overall prey size between faecal and regurgitate samples, prey weights for all taxa were pooled at each site for each time period and were then assigned to eleven octaval classes, i.e. those with limits of 0.125, 0.25, 0.5, 1, 2, 4 mg etc. (after Hespenheide[13]). This has the effect of transforming the data to logarithms of base two, thereby normalizing the prey weight frequency distributions. The form and location (median) of the prey weight distribution in each faecal sample was compared with that in the corresponding regurgitate sample by a Kolmogorov–Smirnov two-sample test. To test for differences in size within individual taxa, data from the six sites were pooled within time periods to obtain sufficient sample sizes, and a Mann–Whitney *U*-test was used to test for differences between the median prey size in the two pellet types.

Where analysis involved repeated comparisons of related data the initially accepted significance level ($P = 0.05$) was decreased according to the Bonferroni inequality,[14] although those tests significant at $P < 0.05$ are also indicated.

RESULTS

In total, 210 faecal and 210 regurgitate pellets were examined, containing the remains of 1648 and 1655 prey items, respectively. The TWINSPAN classification (Fig. 1) illustrates the similarity in the proportional taxonomic composition of each faecal and regurgitate sample from the same site and time period. Most faecal/regurgitate sample pairs were more similar (or at least as similar) to each other than to other samples. The classification was arrested at level 7 with five clusters still containing more than two samples. TWINSPAN could not ordinate these groups to produce a further dichotomy as the samples in these clusters were too similar.

Only two of the possible 35 faecal/regurgitate comparisons did not pair in the final clusters (samples underlined in Fig. 1). Araglin B October 1992 failed to pair due to a greater percentage of Baetidae in the regurgitate than faecal sample (35.4% versus 15.6%) and Douglas October 1992 failed to pair due to the presence of Glossosomatidae in the regurgitate sample (at 5.6%), which was absent from the faecal sample. Overall, the percentage contributions of taxa in faecal and regurgitate samples were highly correlated (Table 1).

Table 1. Correlation of the percentage contribution by number of each prey taxon to faecal and regurgitate pellets. Data from all sites were pooled for each time period.

Time	r	P	n
Jan 1991	0.861	< 0.001	43
Jan 1992	0.839	< 0.001	53
July 1991	0.873	< 0.001	48
July 1992	0.845	< 0.001	51
Nov 1991	0.602	< 0.001	40
Oct 1992	0.850	< 0.001	44

The adjusted significance level is $P = 0.008$.

There was no difference in the percentage contribution of any one taxon to the faecal or regurgitate samples, i.e. no taxon was under- or over-represented in the faecal or regurgitate pellets (Table 2).

There was a significant difference in prey size between sites ($F_{4,3302} = 15.99$, $P < 0.01$), months ($F_{2,3302} = 58.64$, $P < 0.001$) and years ($F_{1,3302} = 25.42$, $P < 0.001$) but not between pellet types ($F_{1,3302} = 0.65$, $P = 0.421$). When pair-wise comparisons of prey size, all taxa pooled, were undertaken (Table 3), only two of the possible 35 sample pairs differed significantly at the adjusted P level (0.0014). A further two were significant at $P = 0.05$. In all four cases, however, it was the faecal samples, not the regurgitate samples, that exhibited the larger median prey size.

When prey sizes were examined within taxa (Table 4), only one of the possible 29 comparisons was significant at the adjusted P level (0.0017). A further test was significant at $P = 0.05$. In both cases, again, it was the faecal samples, not the regurgitate samples, that exhibited the larger median prey size, and neither case (Simuliidae and Baetidae) involved prey of large average size.

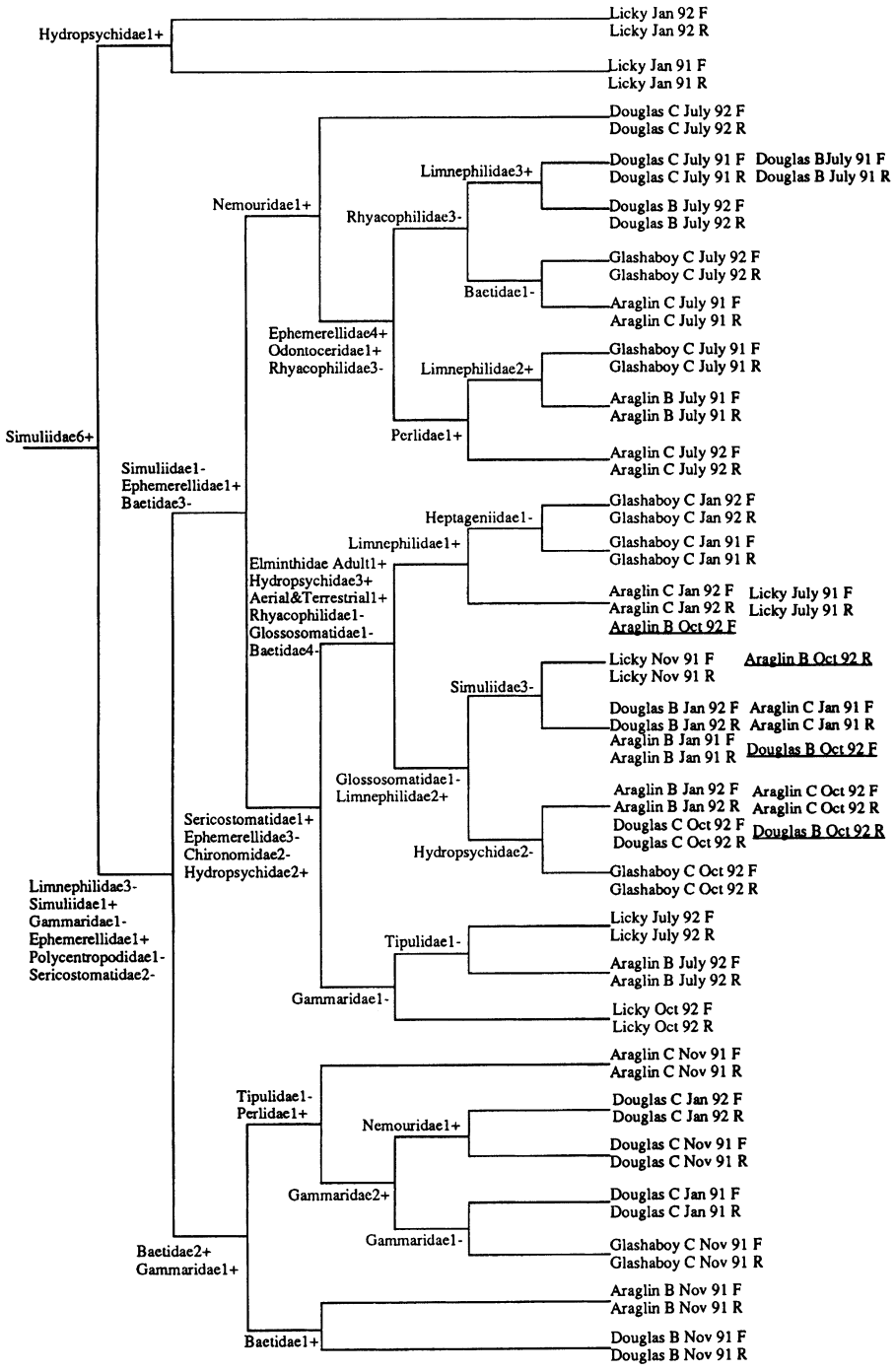

Figure 1. TWINSPAN classification of Dipper diet as represented by faecal (F) and regurgitate (R) pellets. The taxa listed are the diagnostic pseudo-species used to effect the dichotomy at each division (for details see Data Analysis in Methods and Endnote). Diagnostic pseudo-species with a preference for the upper cluster are given a positive sign, those with a preference for the lower cluster have a negative sign. The two faecal/regurgitate pairs which failed to match in final clusters are underlined.

Table 2. Wilcoxon matched pairs tests on the percentage contribution by number of each taxon to faecal and regurgitate pellets.

	Median percentage by number in pellet				
Taxon	*Faecal*	*Regurgitate*	T	P	n
Gammaridae	2.33	3.34	8.0	ns	6
Elminthidae A.	5.10	3.01	–	–	4
Elminthidae L.	2.50	0.00	–	–	1
Nemouridae	1.19	7.94	–	–	5
Perlidae	2.38	1.28	–	–	4
Ephemerellidae	23.75	30.58	26.0	ns	12
Heptageniidae	1.28	0.79	15.5	ns	8
Baetidae	12.14	15.56	166.0	ns	27
Tipulidae	1.04	1.04	–	–	3
Simuliidae	18.63	28.34	90.0	ns	20
Chironomidae	7.54	15.53	–	–	4
Other Diptera	7.03	6.51	–	–	2
Hydropsychidae	13.86	12.98	155.0	ns	27
Polycentropodidae	2.31	3.33	11.0	ns	7
Rhyacophilidae	7.50	5.40	135.0	ns	23
Philopotamidae	2.86	0.00	–	–	1
Limnephilidae	7.96	7.42	212.0	ns	30
Odontoceridae	1.19	0.79	11.0	ns	9
Glossosomatidae	2.03	2.10	25.5	ns	10
Sericostomatidae	2.47	2.47	31.0	ns	15
Goeridae	3.13	0.56	12.0	ns	7
Lepidostomatidae	13.75	0.00	–	–	2
Lymnaeidae	1.43	1.15	–	–	4
Aerial & terrestrial	3.30	11.31	7.0	ns	9

Data from all sites and time periods were pooled for each taxon. The adjusted significance level is $P = 0.0038$, but no tests are significant at $P = 0.05$. *n* is the number of matched pairs (or sample size where there were insufficient data for analysis). A. = Adult, L. = larvae.

DISCUSSION

The problems presented by faecal analysis due to differential digestion of 'soft' and 'hard' bodied prey have been discussed by a number of authors.[6,15] Despite this potential bias, a number of studies suggest that faecal analysis is an accurate method of assessing the proportions of taxa in the diet of insectivorous birds. Poulsen & Aebischer[5] found no significant difference between the dietary proportions of prey taxa in nestling Skylarks *Alauda arvensis* when assessed by neck-collar samples and faecal pellets, nor did Davies[2] when applying the same method to Spotted Flycatcher chicks. Davies[1] fed two types of fly commonly encountered in the wild to captive Pied Wagtails *Motacilla alba yarrelli* and found good proportional agreement between the ratio of prey eaten and those found in the faecal samples. There was no difference in the recovery of the wings used for identification between the two fly taxa, despite one taxon being half the size of the other. Dippers feed on invertebrates that have recognizable hard parts (mandibles, head capsules, wings, gnathopods, chaetae, shell spires) and which appear to pass through the gut undigested (see also ref. 7). Consequently, the Dipper provides an ideal species with which to compare different methods of dietary analysis.

Comparing regurgitate pellets with faecal pellets is not the same as comparing known food or collar samples with faecal pellets as regurgitates have still undergone some digestion, although less so than faecal pellets. However, good agreement between faecal and regurgitate pellets does increase confidence that these techniques accurately reflect the proportion of different prey taxa in the diet. In

Table 3. Kolmogorov–Smirnov two-sample tests on prey size frequency distribution in faecal and regurgitate pellets.

		Median size (mg dry mass) in pellet				n	
Site	*Time*	*Faecal*	*Regurgitate*	d_{max}	P	*Faecal*	*Regurgitate*
Araglin B	Jan 91	0.64	0.64	0.023	ns	67	71
Araglin C	Jan 91	0.94	2.68	0.190	ns	36	46
Douglas C	Jan 91	4.62	2.31	0.117	ns	37	30
Glashaboy C	Jan 91	3.32	2.23	0.155	ns	43	41
Licky	Jan 91	0.40	0.25	0.212	<0.0014	288	268
Araglin B	Jan 92	0.51	0.94	0.180	ns	45	52
Araglin C	Jan 92	3.85	3.85	0.098	ns	44	33
Douglas B	Jan 92	1.28	0.51	0.158	ns	23	25
Douglas C	Jan 92	2.27	0.41	0.326	0.05<*P*>0.0014	41	37
Glashaboy C	Jan 92	2.75	1.88	0.158	ns	71	67
Licky	Jan 92	0.40	0.40	0.028	ns	136	153
Araglin B	July 91	1.88	1.29	0.245	ns	46	56
Araglin C	July 91	0.88	0.30	0.141	ns	60	52
Douglas B	July 91	1.87	1.87	0.069	ns	38	56
Douglas C	July 91	7.56	9.09	0.092	ns	76	76
Glashaboy C	July 91	1.06	0.53	0.107	ns	35	54
Licky	July 91	0.40	0.40	0.080	ns	46	56
Araglin B	July 92	0.30	0.24	0.100	ns	70	87
Araglin C	July 92	0.60	0.32	0.238	0.05<*P*>0.0014	76	96
Douglas B	July 92	0.60	0.75	0.137	ns	57	68
Douglas C	July 92	1.22	0.75	0.257	ns	20	7
Glashaboy C	July 92	2.08	1.08	0.153	ns	44	86
Licky	July 92	0.32	0.25	0.026	ns	53	46
Araglin B	Nov 91	5.31	4.62	0.049	ns	18	17
Araglin C	Nov 91	6.58	6.89	0.150	ns	10	8
Douglas B	Nov 91	7.21	8.67	0.143	ns	5	7
Douglas C	Nov 91	2.80	2.57	0.178	ns	29	18
Glashaboy C	Nov 91	2.72	2.72	0.105	ns	27	26
Licky	Nov 91	10.42	0.70	0.569	ns	13	5
Araglin B	Oct 92	0.37	0.37	0.061	ns	13	19
Araglin C	Oct 92	0.37	0.37	0.116	ns	68	68
Douglas B	Oct 92	2.32	0.37	0.493	<0.0014	46	53
Douglas C	Oct 92	0.37	0.37	0.060	ns	49	36
Glashaboy C	Oct 92	0.32	0.32	0.062	ns	47	25
Licky	Oct 92	0.25	0.27	0.107	ns	32	34

Prey from all taxa were pooled for each site and time period. The adjusted significance level is $P = 0.0014$.

this study excellent agreement was found between the proportions of prey in the faecal and corresponding regurgitate samples (Fig. 1, Table 1). No taxon, for which there were sufficient data to perform statistical analysis, was over- or under-represented in the faecal or regurgitate samples (Table 2). Ormerod & Tyler also found good agreement between the percentage contribution by number of taxa in Dipper faecal and regurgitate pellets in mid-Wales in winter.[4] These authors suggested that only Molluscs were slightly over-represented in the regurgitates. In this study there were insufficient data to test for a difference in the percentage contribution of Lymnaeidae, the only Mollusc in the diet (median values of 1.43% in faecal samples and 1.15% in regurgitate samples).

One explanation for the differences in composition of faecal and regurgitate pellets reported by Davies[2] is that Spotted Flycatchers may use regurgitate pellets to eject the remains

Table 4. Mann–Whitney *U*-test on median prey size in faecal and regurgitate pellets within each taxon.

		Median size (mg dry mass) in pellet				n	
Time	*Taxon*	*Faecal*	*Regurgitate*	U / Z	P	*Faecal*	*Regurgitate*
Jan 1991	Baetidae	0.51	0.51	0.0469	ns	22	22
Jan 1991	Simuliidae	0.40	0.25	5.5494	<0.0017	322	316
Jan 1991	Rhyacophilidae	3.85	3.21	0.5488	ns	32	29
Jan 1991	Hydropsychidae	2.75	2.75	171.5	ns	18	19
Jan 1991	Limnephilidae	13.74	22.83	1.2954	ns	45	48
Jan 1991	Sericostomatidae	2.31	2.56	84.0	ns	14	12
Jan 1992	Baetidae	0.37	0.20	2.0455	0.05<*P*>0.0017	32	40
Jan 1992	Simuliidae	0.40	0.40	0.4472	ns	159	179
Jan 1992	Hydropsychidae	2.27	2.27	0.0927	ns	58	59
Jan 1992	Rhyacophilidae	5.55	4.62	1.4661	ns	28	38
Jan 1992	Limnephilidae	17.32	23.88	0.6891	ns	46	17
Jul 1991	Ephemerellidae	0.27	0.24	0.4246	ns	48	70
Jul 1991	Baetidae	0.14	0.14	236.0	ns	16	27
Jul 1991	Simuliidae	0.40	0.40	0.1163	ns	37	29
Jul 1991	Hydropsychidae	1.55	1.55	0.8958	ns	105	96
Jul 1991	Rhyacophilidae	2.95	2.68	0.9494	ns	32	34
Jul 1991	Limnephilidae	10.93	12.53	0.7480	ns	54	64
Jul 1992	Ephemerellidae	0.60	0.47	0.5911	ns	124	133
Jul 1992	Baetidae	0.11	0.11	0.1296	ns	46	55
Jul 1992	Simuliidae	0.32	0.25	1.3131	ns	39	73
Jul 1992	Hydropsychidae	1.55	1.28	1.5712	ns	45	51
Jul 1992	Rhyacophilidae	3.85	3.21	0.9337	ns	28	35
Jul 1992	Limnephilidae	12.53	18.11	110.0	ns	14	15
Nov 1991	Hydropsychidae	2.27	1.06	87.5	ns	13	9
Nov 1991	Limnephilidae	9.51	9.51	1.2732	ns	34	25
Oct 1992	Baetidae	0.27	0.27	0.1262	ns	130	130
Oct 1992	Simuliidae	0.25	0.32	0.5167	ns	47	49
Oct 1992	Rhyacophilidae	4.62	4.62	224.0	ns	25	15
Oct 1992	Limnephilidae	12.29	31.48	135.0	ns	16	13

Data from all sites were pooled for each taxon and time period. Only those comparisons with sufficient data for the test are shown. *U*/*Z* is the larger *U* statistic or *Z*, the normal approximation of *U*, as appropriate. The adjusted significance level is $P = 0.0017$.

of large prey. If Dippers also produce regurgitates for this reason, any study of prey selection or size in this species may be biased when based on faecal analysis alone. In this study, despite significant variation in prey size between sites and time periods within each pellet type, virtually no difference was found between prey sizes in the faecal and corresponding regurgitate pellets. This was the case both when all prey taxa were pooled (Table 3) and when each taxon was considered separately (Table 4). Where significant differences were found, the absolute difference between the medians was generally low (0.15–1.95 mg in Table 3; 0.15–0.17 mg in Table 4), and did not involve sites or taxa with large median prey size. In addition, in all these cases it was the faecal pellets, not the regurgitates, which had the larger median prey size.

It is concluded, therefore, that there is no significant difference in the taxonomic composition of prey remains in the faecal and regurgitate pellets of Dippers in this study area. In addition, there is virtually no difference in the size of prey in faecal and regurgitate pellets, and no evidence that Dippers use regurgitates to eject the remains of large prey. We conclude that the diet of Dippers in this study area may be assessed solely by faecal pellets, which are much easier to find than regurgitate pellets, without the risk of under- or over-estimating either taxonomic composition or prey size.

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ENDNOTE

a. The TWINSPAN procedure performs a one-dimensional ordination by reciprocal averaging (RA), in order to achieve an initial partitioning of the data. Ordinations are then performed iteratively, in which the taxa quantities (actually presence/absence of pseudo-species) that characterized the RA axis extremes are emphasized, to polarize the samples. These pseudo-species are the diagnostic indicators of the ordination. The axis is then broken at its centre of gravity (centroid) to produce two subsets (clusters). Diagnostic pseudo-species with a preference for the upper cluster are given a positive sign, e.g. Simuliidae3+, those with a preference for the lower cluster have a negative sign. The entire procedure is repeated on the two subsets to produce four clusters and so on until each cluster has a chosen minimum number of samples (two in this study).[10–12]

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APPENDIX 1

Regression (log10$y = a + bx$) of dry mass (mg) (y) on mandibular length (mm) (x) for potential prey taxa of Dippers in southwest Ireland.

	Taxonomic group[a]	b	a	r^2	n
Plecoptera	Nemouridae N.[b]	4.88	–2.01	0.60***	47
	Perlidae N.[c]	1.90	–1.35	0.85***	42
Ephemeroptera	Ephemerellidae N.	3.97	–2.21	0.75***	41
	Heptageniidae N.	2.83	–1.51	0.89***	49
	Baetidae N.	5.50	–3.04	0.62***	48
Diptera	Simuliidae L.	4.01	–1.80	0.77***	64
Trichoptera	Hydropsychidae L.	3.31	–1.63	0.90***	50
	Polycentropodidae L.	1.92	–1.61	0.79***	42
	Rhyacophilidae L.	3.16	–1.31	0.76***	47
	Philopotamidae L.	3.75	–2.52	0.81***	46
	Limnephilidae L.	1.60	–0.10	0.89*	122
	Odontoceridae L.	1.91	–0.90	0.99***	49
	Glossosomatidae L.	3.85	–1.39	0.91***	44
	Sericostomatidae L.	3.34	–1.64	0.83***	46
	Goeridae L.	5.70	–1.87	0.72***	42
	Lepidostomatidae L.	0.75	–0.53	0.98***	23

***$P < 0.001$; *$P < 0.05$.

[a]L. = Larvae, N. = nymph, A. = adult (these indications are omitted from figures but still apply).

[b]Includes the nymphs of the families Nemouridae, Leuctridae & Taenioptergyidae.

[c]Includes the nymphs of the families Perlidae, Perlodidae & Chloroperlidae.

APPENDIX 2

Mean dry mass (mg) for potential prey taxa of Dippers in southwest Ireland.

	Taxonomic group[a]	*Time*[b]	*Mean dry mass (mg)*	n
Amphipoda	Gammaridae	Dec–Mar	3.58	50
		Apr–Aug	1.41	50
		Sep–Nov	2.57	50
Coleoptera	Gyrinidae L.		0.29	28
	Elminthidae A.		0.71	50
	Elminthidae L.		0.40	50
	Hydraenidae A.		0.22	22
	Helodidae L.		0.29	12
	Dytiscidae A.		0.82	19
	Dytiscidae L.		0.15	4
	Haliplidae A.		0.35	6
	Hydrophilidae A.		0.59	5
Ephemeroptera	Caenidae N.		0.07	50
	Ephemeridae N.		4.48	6
Diptera	Tipulidae L.		3.27	50
	Chironomidae L.		0.26	50
	Other Diptera L.[c]		1.22	27
Trichoptera	Psychomyidae L.		0.35	5
	Hydroptilidae L.		0.07	4
	Leptoceridae L.		0.58	12
Gastropoda	Ancylidae		1.32	50
	Lymnaeidae		2.72	50
Bivalvia	Sphaeridae		0.07	11
Hirundinea	Glossiphoniidae		0.26	36
	Erpobdellidae		2.16	12
	Piscicolidae		0.24	4
Acari	Hydracarina		0.07	21
Miscellaneous	Pupae[d]		2.89	50
	Aerial & terrestrial[e]		4.17	50
	Fish egg		0.10	10
	Oligochaeta		0.18	25

[a]L. = Larvae, N. = Nymph, A. = Adult (these indications are generally omitted from figures but still apply).
[b]All values are annual means unless otherwise indicated.
[c]All Diptera larvae except Tipulidae, Simuliidae & Chironomidae.
[d]Pupae of Trichoptera, Simuliidae & Chironomidae.
[e]Includes: adult Diptera, Trichoptera, Plecoptera & Ephemeroptera; and Hemiptera, Homoptera, Diploda, Formicoidea, Isopoda, Araneae & terrestrial Coleoptera.

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