

The foraging of hedgerow birds in four types of vegetation in Karbach

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Abstract. For guiding conservation of birds, and furnishing fresh evidence to "optimal foraging strategy (OFS)". This study was made in the foraging of hedgerow birds in four types of vegetation (OM-overgrown meadow, MM-managed meadow, GM-grazed meadow, and DV-dry grass vegetation) through the non-breeding season. The results shown:

(1) There is no significant difference distribution of the invertebrate in four types of the vegetation (F ratio = 0.258, P = 0.856), however there is significant difference foraging rate of birds (F ratio = 3.519, P = 0.193).

(2) There is negative regression between the highness of fresh grass and the foraging rate of birds in the three types of fresh meadow (r^2 = 0.996, intercept = -14.55, slope = 14.358). This investigation highlights the importance of GM.

(3) In DV, the forage of birds was less than both in MM and GM, but many birds fed there, and the forage species was the most one in four types of the vegetation.

The analysis shows (1) the foraging of the hedgerow birds should follow OFS, and (2) the most is the diversity of dry grass, the most is the diversity of forage species in the four types of the vegetation.

Keywords: hedgerow birds, foraging, vegetation

Introduction

The diet of birds is in general terms reasonably known. It includes a wide range of invertebrates (especially insects) and plant (especially seeds) (Collinge 1924-1927; Davison 1981; Hails and Amirrudin 1981; Bishton 1986). The items can be found in many places. However, where has more abundant food and where birds harvest the food efficiently, as a result of evolutionary selection pressures, animals will tend to forage there (Kerbs 1978). OFS always includes the point of patch choice or foraging space (Schoener 1971; Pyke et al. 1977; Krebs 1978). OFS presumed that animals should be either time-minimizers or energy- (or food-) maximizers and hence should forage in such a way that their net rate of intake of energy (or food) is maximized

(Schoener 1971), thus animals have the highest chance of surviving.

Nowadays, highly developed industries and communications have greatly reduced the space of the free-living birds. In those limited space, utilization of pesticide and chemical fertiliser further declines the usable space of birds. Some habitats have been altered in structure and in extent by man's activities (Osborne 1984; Cody 1985; Lack 1987). Man's activities not only directly threaten birds survival though influencing the food abundant (Inglis et al. 1990). It is on the increase that the diversity and number of birds are threatened. For the risk of maintaining the diversity and number of birds, man need to gain the information on environment and way of life about birds, such as forage place, foraging ways, to use this information to aid explaining both the birds selection of their particular habitat and their very limited temporal exploitation of it, to reserve some area for birds, and guide conservation of birds.

To try highlighting above-mentioned question and offering fresh evidence for OFS, this study was designed the foraging of birds in different types of vegetation and the availability of potential prey through the non-breeding season.

Material and Methods

Observations were made in a period between August 3rd - November 3rd, 1989, close to a small village Karbach (49° 54' N, 10° 34' E), Wurzburg, Germany. Figure 1 is the map of the study area. There is woodland around the north, east and south of the map's outline, farmland is laid in the west. There is some abandoned orchards and several types of meadows. In the edges of the orchards and meadows often marked hedgerow or trees.

The quantitative data of birds foraging mainly collected between 0700 and 1230h on days when birds fed much more (Spott 1989), and only the bouts that birds foraged on the ground and the surface of the grass was counted. The qualitative information, such as the bouts of birds foraging in the tree and hedgerow, was randomly recorded at observation interval and in the afternoon.

For quantitative observation, a certain number of determined size of plots in every type of vegetation was chosen. When observing, the observer positioned behind hedgerow or trees,

Types of Size Vegetation	Total Time Observed (min.)	Total Size Observed (m ²)	Numbers of Plots	Average time Observed for One Plot (min.)	Average of Plots (m ²)
OM	1380	7500	3	460	2500
MM	1380	9755	4	345	2439
GM	2850	18000	6	475	3000
DV	2760	15000	6	460	2500

Table 1. The number and size of plots, and observed time in four types of vegetation.

and stood at least 20 meters far away from the observed plot. Every plot was continuously observed 5 or 10 minutes, then observed next close plot. Next day the observed went to observe the next type of vegetation first, thus every four or eight days made a circle. Table 1 shows the number of plots and observed minutes for four types of vegetation. Observations were made with binoculars and one digital counter was recorded birds foraging times when necessary, and an electronic stopwatch was used timer.

Foraging ratio of the birds was calculated by following formula:

$$f = \frac{x}{t/60} \times \frac{10000}{s} \text{ (bouts/10000m}^2 \times \text{hr.)}$$

where: x -- total bouts of a certain species foraging in the vegetation i.
 t -- total minutes of observation in the vegetation i.
 s -- the average size of the plot in vegetation i.

In October, three methods were used to collect invertebrates from studied vegetation:

- (1) To sample grasshoppers, transect method was taken and one sampling is 10m long and 1m wide;
- (2) The more active invertebrate fauna was sampled by taking sweep-net samples. Every sample swept 10 times; The catch was immediately counted and identified to major taxonomic groups (Chinery 1973; Paul 1977);
- (3) Surface-active invertebrates were sampled by pitfall traps. Each trap contained 160cm³ 4% formalin, 6.3cm in diameter at the top, 7.5cm in diameter at the bottom, and 11cm deep; the traps were set in mid-October and emptied fortnightly though to the end of October. The catch was preserved in 75% alcohol and later counted and identified to major taxonomic groups (Chinery 1973; Paul 1977).

Eight transect samples were made in managed meadow and 7 in the other vegetation; 8 sweep-net samples were made in each type of vegetation; 3 pitfall trap samples were made in each vegetation.

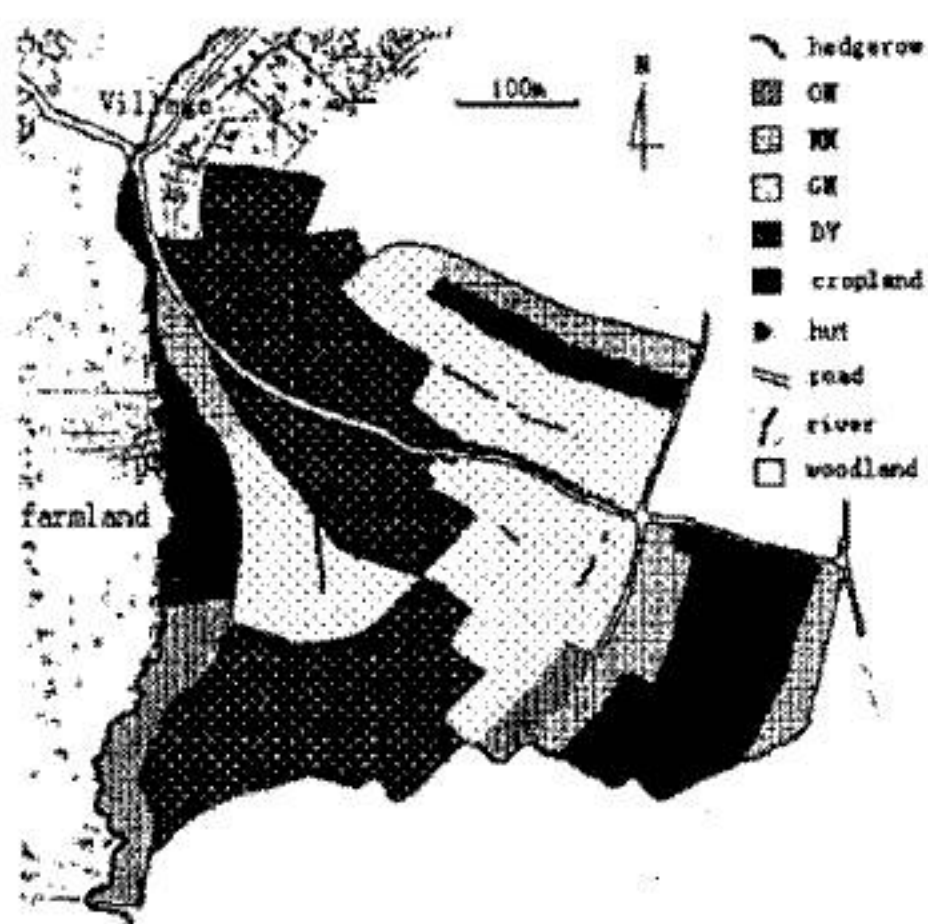


Fig. 1. In this area, studied vegetation was grossly categorized into four main types: (1) Overgrown meadow (OM) - formed by the freshly dense grass high about 20-30cm, during the study period, vegetation was not mowed. (2) Managed meadow (MM)- formed by the fresh grass about 10-20cm in the height, it was mowed two times during the study period. (3) Grazed meadow (GM)- average every three weeks was grazed one week by the cows, generally composed by lower than 10cm of the fresh grass, and the grass high about 5-6cm in most of the area. (4) Dry grass vegetation (DV) - the abandoned orchards covered by overgrown dry grass generally more than 50cm high, with some apple trees and a few of pear, walnut and conifer.

Results

1. Basic activities of birds

Table 2 presents the activities and active range of the observed birds. In the study are a total of 44 bird species was observed, but only 19 species foraged in the grass of the designed vegetation. Four predatory species were recorded, occasionally Common Nighthawk and Sparrowhawk flying across the air, sometimes Red Kite hovering in the sky, and Buzzard often circling in the air, however, they have never been seen to catch any prey. Seven species did not feed in the study area, only sat, and stood in the tree or/and hedgerow. They were Coal Tit, Crow, Dunnock, House Sparrow, Lesser Spotted Woodpecker, Nuthatch, and Tree Sparrow. Another species, Pied Wagtail, only stood

Latin Name	Abb.	OM	MM	GM	DV	Hedge	Tree	Air
<i>Dryocopus martius</i>	Bw						X	
<i>Turdus merula</i>	Bb		X	X	X	X	X	
<i>Sylvia atricapilla</i>	Bc					X	X	
<i>Parus caeruleus</i>	Bt				X	X	X	
<i>Pyrrhula pyrrhula</i>	Bf						X	
<i>Buteo buteo</i>	Bu							*
<i>Fringilla coelebs</i>	Cf			X	X		X	
<i>Phylloscopus collybita</i>	Cc					X	X	X
<i>Parus ater</i>	Ct						*	
<i>Caprimulgus europaeus</i>	Cn							*
<i>Corvus corone</i>	Cr						*	
<i>Prunella modularis</i>	Do					*		
<i>Regulus ignicapillus</i>	Fc					X		
<i>Sylvia borin</i>	Ga					*	X	
<i>Regulus regulus</i>	Gc						X	
<i>Carduelis carduelis</i>	Gf				X		*	
<i>Dendrocopos major</i>	Gw				X		X	
<i>Parus major</i>	Gt	X	X	X	X	X	X	
<i>Picus viridis</i>	Gr			X				
<i>Carduelis chloris</i>	Gh						X	
<i>Passer domesticus</i>	Hs					*	*	
<i>Hippolais icterina</i>	Iw						X	X
<i>Garrulus glandarius</i>	Ja		X	X	X	*	*	
<i>Dendrocopos minor</i>	Ls						*	
<i>Sylvia curruca</i>	Lw						X	
<i>Anthus pratensis</i>	Mp			X				
<i>Turdus viscivorus</i>	Mt			X	X	*	*	
<i>Sitta europaea</i>	Nh						*	
<i>Ficedula hypoleuca</i>	Pf			X			*	
<i>Motacilla alba</i>	Pw!							
<i>Milvus milvus</i>	Rk							*
<i>Lanius collurio</i>	Rb				X			
<i>Phoenicurus phoenicurus</i>	Rs		X	X		*	*	
<i>Erihacus rubecula</i>	Ro	X	X	X	X	*	X	
<i>Turdus philomelos</i>	St		X	X	X	*	*	
<i>Accipiter nisus</i>	Sh							*
<i>Anthus trivialis</i>	Tp						X	
<i>Passer montanus</i>	Ts						*	
<i>Certhia familiaris</i>	Tc						X	
<i>Parus montanus</i>	Wt				X	*	X	
<i>Phylloscopus trochilus</i>	Ww					X	X	
<i>Troglodytes troglodytes</i>	Wr		X		X		*	
<i>Motacilla flava</i>	Yw			X	X			
<i>Emberiza citrinella</i>	Yh		X	X	X	*	X	

Table 2. Species and activating places of birds were recorded in the study area. x-- including forage, *-- activities without forage, !-- standing in the hut.

in the hut of the study area. Other 13 species did not feed in the investigated meadow and dry grass, but they fed in the trees and/or hedgerow (Table 3).

2. Invertebrates

Three invertebrates can only be regarded as an approximate and relative abundance in four types of the vegetation. It maybe does, however, provide a valid means of obtaining comparisons and determining some reasons why the birds

liked to forage in certain vegetation. Grasshoppers were most in managed meadow where grew middle-high fresh grass than the other vegetation, in grazed meadow and dry grass vegetation were next to, and in overgrown meadow, were least common. More active invertebrates swept from three types of the fresh grass vegetation were more or less similar, but different from dry grass vegetation. In fresh grass vegetation, Hemiptera were the commonest. Archnida and Diptera were next common ones. In overgrown and managed meadow, Coleoptera

Transect								
Vegetation	OM	MM	GM	DV				
Grasshopper	4	32	20	20				
Sweep-net								
	3-7mm				>7mm			
Vegetation	OM	MM	GM	DV	OM	MM	GM	DV
Arachnida	37	30	16	58	2	2	0	0
Orthoptera	0	0	0	0	2	2	2	1
Psocoptera	0	0	0	4	0	0	0	0
Hemiptera	51	70	27	20	25	19	0	3
Trichoptera	0	0	0	0	2	3	1	3
Diptera	11	13	32	4	1	0	0	0
Hymenoptera	1	1	3	7	1	2	0	2
Coleoptera	11	9	1	8	3	0	0	0
Miscellaneous	0	1	0	2	12	3	0	13
Total Number	111	124	79	103	48	31	3	22
Pitfall Trap								
Mollusca	2	0	0	6	1	0	0	0
Annelida	0	0	0	0	3	0	1	2
Arachnida	14	11	15	7	2	1	0	1
Isoloda	2	0	0	5	0	0	0	1
Myriopoda	2	0	3	0	11	1	2	6
Collembola	7	2	21	14	0	0	0	0
Hemiptera	7	11	7	5	0	0	0	0
Diptera	18	21	11	22	0	2	0	0
Hymenoptera	3	1	10	32	0	0	0	0
Coleoptera	76	131	47	107	27	19	33	8
Miscellaneous	4	3	4	2	2	2	2	3
Total Number	135	180	118	200	46	25	38	21

Table 3. Invertebrates collected from the studied vegetation. Figures denote the total individuals from the samples. Here only gives invertebrates that the size larger than 3mm.

also was an abundant group. In dry grass vegetation, Arachnida was most abundant, and next one was Hemiptera. Surface-active invertebrates collected from four types of the vegetation were broadly similar in composition. Coleoptera were the most abundance. The next most abundant group was Diptera, Hymenoptera, Hemiptera and Archnida also featured quite prominently in the potential diet. Figure 2 sums up the relative number of the invertebrates collected in vegetation. It shows that the invertebrate's abundance is more or less similar in four types of the vegetation. Although managed and dry vegetation possessed more invertebrates, and grazed meadow had less ones, Analysis of Variance shows that distribution of the invertebrate in four types of the vegetation is no significant difference (F ratio = 0.258, P = 0.856).

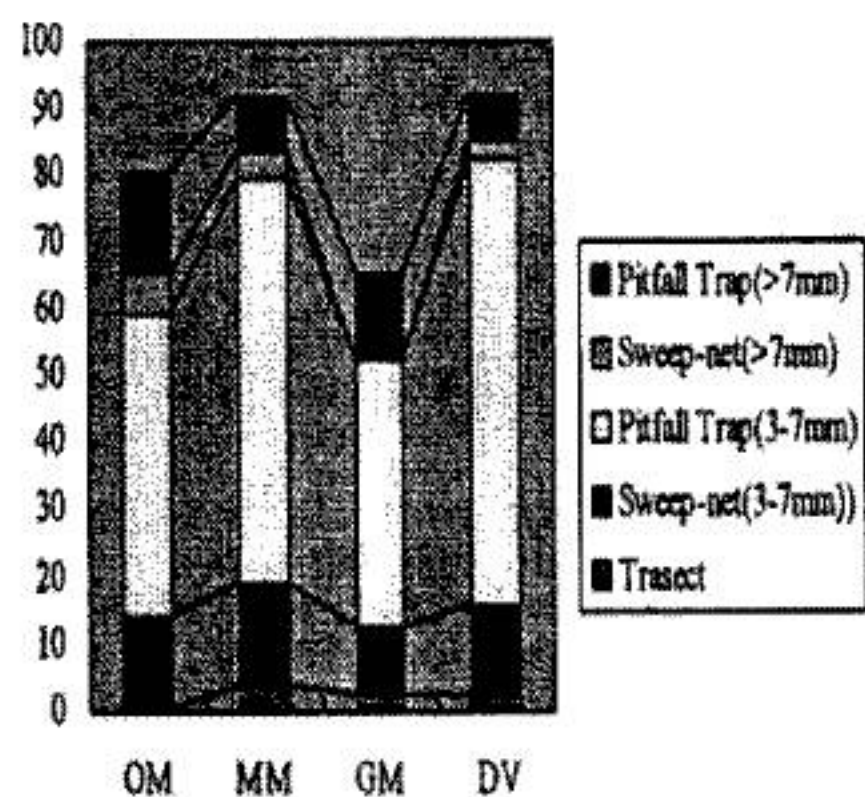


Fig. 2. Relative number (=total individuals/a sample) of invertebrates that was collected from four types of vegetation.

3. Birds foraging

Birds foraged in all four types of the vegetation and a preference was shown for certain vegetation (Table 2, Fig. 3). There is significant difference Analysis of Variance foraging rate of birds in four types of vegetation (F ratio = 3.519, P = 0.0193). Meadow was the important feeding habitat and grazed meadow was used frequently, 55.67% of the birds foraging in there; 25.22% in managed meadow; Whilst in overgrown meadow, the figure was 0.67%. The proportion of birds foraging in dry grass vegetation was 18.45%. 15 of 19 species foraged in dry grass vegetation, 13 in grazed meadow, 8 in managed meadow, and only 2 species foraged in overgrown meadow.

There is a regression equation between the index of grass high and the foraging rate of birds in the fresh meadows, while it is given $OM = 1, MM = 2, GM = 3$ ($r^2 = 0.996$, intercept = -14.55, slope = 14.358).

Total 602 bouts of forage were recorded in the time of the quantitative observation. Bb, Yh and Ro were main feeders and 64% of the foraging bouts occurred among them. Another 30% of the foraging bouts appeared among Gt, St, Rs, Mt, Ja and Gf. Rest 10 species possessed only 6% of the foraging bouts. Ro and Gt foraged in all vegetation. Bb, Yh, St and Ja foraged widely in vegetation except overgrown meadow. Following birds foraged in narrow vegetation: Mp, Pf and Gr only in grazed meadow; Rb, Wt, Bt, Gf and Gw only in dry grass vegetation.

When feeding in meadow, usually birds neared the line of the hedgerow and infrequently wandered out off the hedge into the open area. However, if many birds fed in a limited meadow, they would spread and intruded into the open area. Besides Ro and Rs, all the other birds stood on the ground and jumped to search food while foraging in managed and grazed meadow. Generally Ro and Rs flight rapidly to the ground to catch the prey then immediately flight back. Gt stand in the straw of grass instead of on the ground when recorded it fed in overgrown meadow.

Feeding in dry grass vegetation, most of ground feeding birds foraged near the base of the hedge and tree. Tits and other small birds liked sticking in the straw of the dry grass to feed, and seldom foraged on the ground. Gf fed both on the straw and on the ground.

Qualitative observation shows that many of birds fed in the trees of the dry grass vegetation. Bb, Ja fed apple. Bt, Gt, Cc, Ww, Gw, and Fc fed invertebrates.

Discussion

As the place of the birds foraging, this investigation highlights the importance of the freshly grazed meadow, and reveals the uselessness of the overgrown meadow. Although there are almost same invertebrates abundant in three types of the freshly meadows, birds hardly foraged in overgrown meadow. Overgrown meadow was wet comparing with managed and grazed meadow. Particularly in the early morning, it was very wet. If birds foraged in overgrown meadow, their plumage would get wet. Severe wetting of plumage has very negative effects on the heat balance of birds (Spott 1989). The OFS points out animals should forage in such a way that their net rate of intake of energy is maximized (Pyke et al. 1977). To maximize the net rate of intake of energy, one of the ways used by animals is to maximize energy intake or to minimize energy cost. Wet plumage of birds would decrease the physical temperature, it makes birds to cost energy for keeping the heat balance. So birds tend to forage in dry meadow to avoid getting wet. Figure 3 was drawn according quantitative observation, which almost made in the morning. Overgrown meadow was wet in the most of time in the morning, so overgrown meadow was not good foraging place for birds. However, qualitative record was also conducted in the afternoon, bouts of birds forage were still not collected.

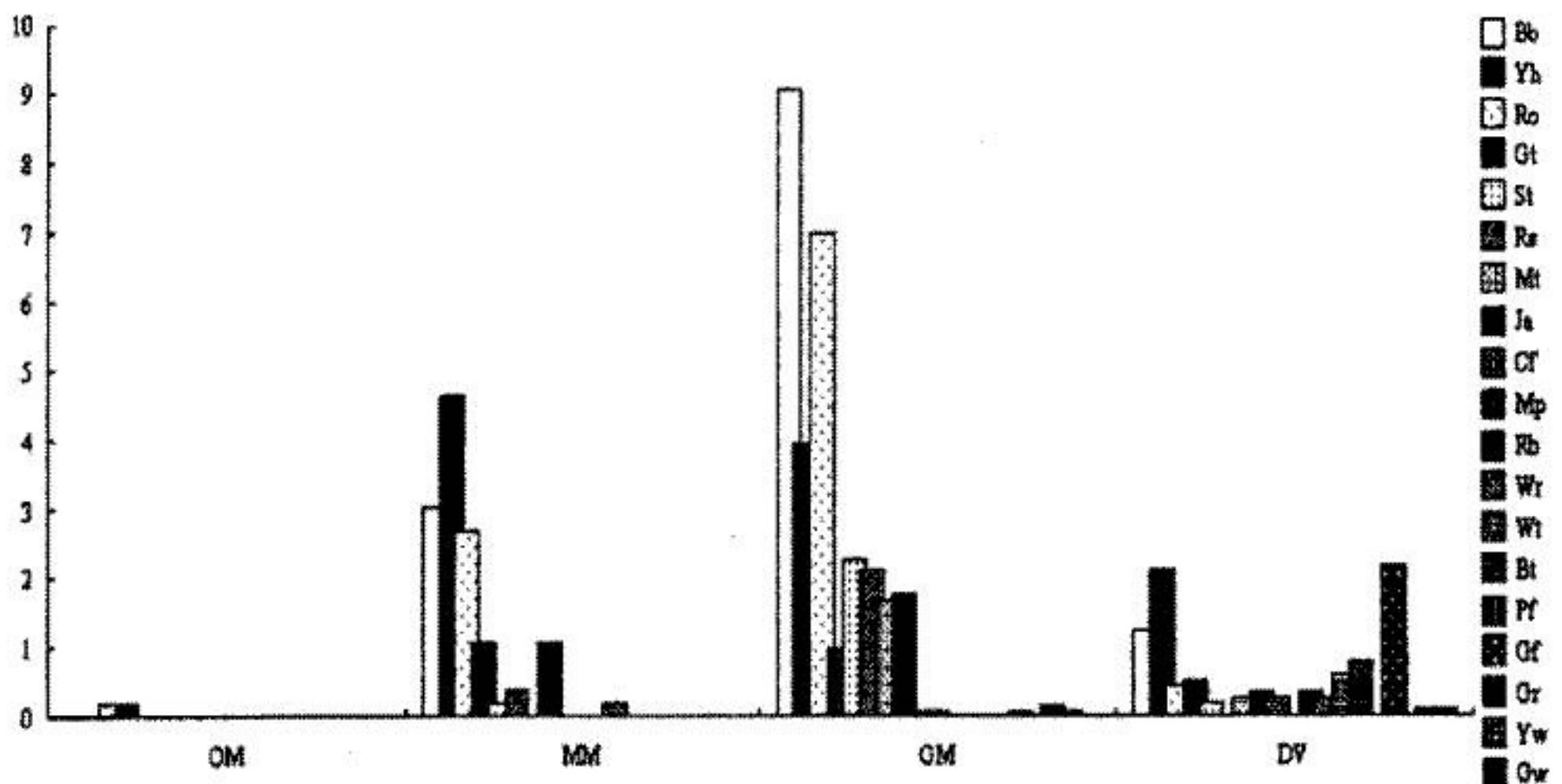


Fig. 3. The rate of the birds forage in four types of vegetation.

Therefore, it is only a part of influence that wet grass burden the birds foraging. Following factor may be more important, that is tall/dense grass is not suitable for ground feeding birds: the structure makes (1) detection prey organisms very difficult (Barnard and Slepheno 1983; Spott 1989), and (2) access and moving very difficult (Spott 1989). Obversely, to perceive through tall/dense grass, visual and also auditory cues of availability may have been more difficult. Birds would spend more time to find the food in overgrown meadow than in the managed and grazed meadows, and in managed meadow than in grazed one. Theremore, the tall/dense grass burden birds foraging speed, they should spend much more time and cost more energy to get through in overgrown meadow. According to the principle of the OFS (Schoener 1971; Pyke *et al.* 1977), birds should forage mainly in grazed meadow, next in managed meadow, then in overgrown meadow and dry grass vegetation.

Abandoned orchards were covered with very tall dry grass. On the ground, birds go through it very difficult. Near the base of the hedge and tree, the grass was much rarer and shorter than the open place, and birds could catch invertebrates easier. Except Rb, most of ground feeding birds foraged in such place. Almost all the small birds fed standing in the straw of the grass, thus they need not access through the dense base of the dry grass. In the grass surface of dry grass vegetation, the forage of birds was less than both in managed and grazed meadow, but many birds fed in the tree, and the forage species was the most one in four types of the vegetation. If it is not ignored the bouts of bird's forage in the tree and it is considered the diversity of bird's species, dry grass vegetation is also an important place of bird's forage.

Except Wr, other 2 species foraging in overgrown meadow and 7 species foraging in managed meadow also were found in grazed meadow. However, 6 species fed only in dry grass vegetation, and 4 species foraged only in grazed meadow. A diversity of species is directly related to structural diversity (Giller 1984; Cody 1985; Begon *et al.* 1988). Dry grass vegetation had more complex structure than other three vegetation. There are more species feeding there. The present study implies to remain more complex vegetation — dry grass vegetation — would keep the more bird species. Three types of the meadows have more similarities in the structure. Only to reserve grazed meadow will keep the almost same bird species as to reserve three types of the meadows. If changing overgrown meadow to managed and grazed ones of changing overgrown and managed meadow to grazed one, it will gives the more usable space to birds as their foraging habitat.

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