

## HUNTING HABITATS OF HARRIERS IN AGRICULTURAL LANDSCAPES OF THE LENINGRAD REGION

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The present paper considers hunting habitat preferences of the Hen Harrier (*C. cyaneus*), Marsh Harrier (*C. aeruginosus*) and Montagu's Harrier (*C. pygargus*), as well as differences between species and sexes in the choice of feeding habitats. The study was carried out in 2003–2005 in a 160 km<sup>2</sup> model area 30 km SW of St. Petersburg. In the study area harriers tended to choose farmland as major feeding habitats during the breeding season. We distinguished 5 types of hunting habitats for harriers: 1) "natural" biotopes (cut-overs, reed-overgrown waters, corridors cut for transmission lines), 2) cereal fields, 3) hayfields, 4) pastures and 5) abandoned farmland (abandoned hayfields and idle fields). During the breeding period, the Hen and Marsh Harriers preferred hunting in hayfields because there were optimal quantities of readily available prey. Montagu's Harrier started visiting hayfields to hunt not earlier than the middle of the breeding period, when the young reached an age of 7–10 days. Broods leaving nest areas always moved to mown hayfields. The Marsh and Montagu's Harriers preferred to take prey from taller grasses than the Hen Harrier. An attempt was made also to evaluate the hunting success of the three species in different habitats.

*Key words:* hunting behaviour, feeding habitat, habitat choice, hunting success.

### ОХОТНИЧЬИ БИОТОПЫ ЛУНЕЙ В УСЛОВИЯХ АГРОЛАНДШАФТА В ЛЕНИНГРАДСКОЙ ОБЛАСТИ.

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В настоящей работе мы рассматриваем биотопические предпочтения в кормодобывании полевого (*C. cyaneus*), болотного (*C. aeruginosus*) и лугового (*C. pygargus*) луней, а также межвидовые и межполовые различия в выборе кормового биотопа.

Работа проводилась в 2003–2005 гг. на модельной территории площадью около 160 км<sup>2</sup>, расположенной в 30 км к юго-западу от С.-Петербурга.

В наших ландшафтных условиях в качестве кормовых биотопов в сезон размножения луни использовали в основном сельскохозяйственные поля. Мы выделяли 5 типов охотничьих биотопов луней: 1) "естественные" биотопы (вырубки, заросшие тростником водоемы, просека ЛЭП), 2) поля, засеваемые зерновыми культурами, 3) сенокосные поля, 4) пастбища и 5) брошенные поля (брошенные сенокосы и залежи).

Полевой и болотный луни в гнездовой период предпочитали охотиться на сенокосных полях из-за оптимальных количества и доступности жертвы на них. Луговой лунь начинал летать на сенокосы за кормом лишь в середине гнездового периода, когда птенцы достигали возраста 7–10 дней. Выводки, покидая гнездовые территории, обязательно выходили на скошенные сенокосные поля. Болотный и луговой луни предпочитали охотиться на более высокой траве, чем полевой. В работе также была сделана попытка оценить успешность охоты всех трех видов в различных биотопах.

*Ключевые слова:* охотничье поведение, кормовой биотоп, выбор биотопов, успешность охоты.

### INTRODUCTION

In studies dealing with the hunting behaviour of harriers (Schipper 1973, 1977, 1978, Simmons 2000), differences between species and sexes in the choice of the feeding habitat are mostly considered from the point of view of the species and sex food specialization. In our study area, small rodents were the main food for all the three harrier species during the breeding season. Checking the composition of cast pellets collected from nests and from the field (when their identity was certain) as well as

remains of harrier meals in the field, we chiefly (90%) found hair and bones of *Microtus* voles. Watching actual hunts, we also saw that when a hunt ended in capturing prey it normally was a vole (visible through binoculars). Hence, habitat preferences of hunting birds depended on other reasons, and we tried to identify them.

Harriers in the study area hunt mainly in farmland. The farmland includes fields of different categories as regards both the use by people (hayfields, pastures, cereal crops and vegetable crops) and the use by birds. We made an attempt to assess the

role of different habitats in the foraging of harriers using an area intensively utilized by people as the example.

### MATERIAL AND METHODS

The study was carried out in 2003–2005 in a 160 km<sup>2</sup> model area 30 km SW of St. Petersburg. The area was chosen due to the presence of all habitats harriers needed – breeding (water-logged or littered cut-overs, overgrown water-bodies) and feeding (farmland) grounds. The area of the fields controlled was ca. 130 km<sup>2</sup> (fig. 1). Three harrier species breed in the study area: the Hen and the Marsh Harriers regularly, Montagu's Harrier, not every year. In 2003, there nested 5 Hen Harrier pairs, 3 Marsh Harrier pairs, and 2 Montagu's Harrier pairs; non-breeding birds of both sexes occurred throughout the season. In 2004, there nested 5 Hen Harrier pairs, 5 Marsh Harrier pairs and 3 Montagu's Harrier pairs. No non-breeding birds were present in the study area that year. In 2005, there nested 5 Hen Harrier pairs and 2 Marsh Harrier pairs. Montagu's Harriers did not breed in the area in 2005. Non-breeding birds of all three species were present throughout the season. Thus, 25–30 adult harriers were constantly present in the study area every breeding season.

Observations in different biotopes totalled 680 hours in two seasons.

In the study area, the main feeding habitats for harriers during the breeding season were fields. We

distinguished 5 types of harrier hunting habitats: 1) "natural" biotopes (cut-overs, reed-overgrown waters, corridors cut for transmission lines, i.e. habitats with a natural vegetation succession), 2) cereal fields, 3) hayfields, 4) pastures, 5) abandoned farmland (abandoned hayfields and idle fields).

Sowing in cereal fields sometimes lasted from late May to early July. Hay mowing began in late June and lasted until early September. Abandoned fields were not treated – grass grew there uncontrolled throughout the season.

The index of abundance of potential prey and its availability was determined for each habitat category (Simmons 2000). Rodent counts were made from May to September by trapping, following the technique by Kucheruk et al. (1963). An indirect indicator of the abundance of small rodents was the number of breeding Short-eared Owls. There were 2 successfully breeding Owl pairs in the study area in 2004, and 5 pairs in 2005.

The parameters selected to estimate prey availability were grass height and thickness (Simmons 2000). Grass height was measured in fields of a certain type with a field tape measure in 15 points ca. 20 m apart arranged along a straight line. Thickness was determined in the same points by estimating the percent cover by eye. Three fields of each type were chosen to this end. Measurements were made twice a month in all model fields on the same days. Fields of different types were compared by mean values of the parameters.

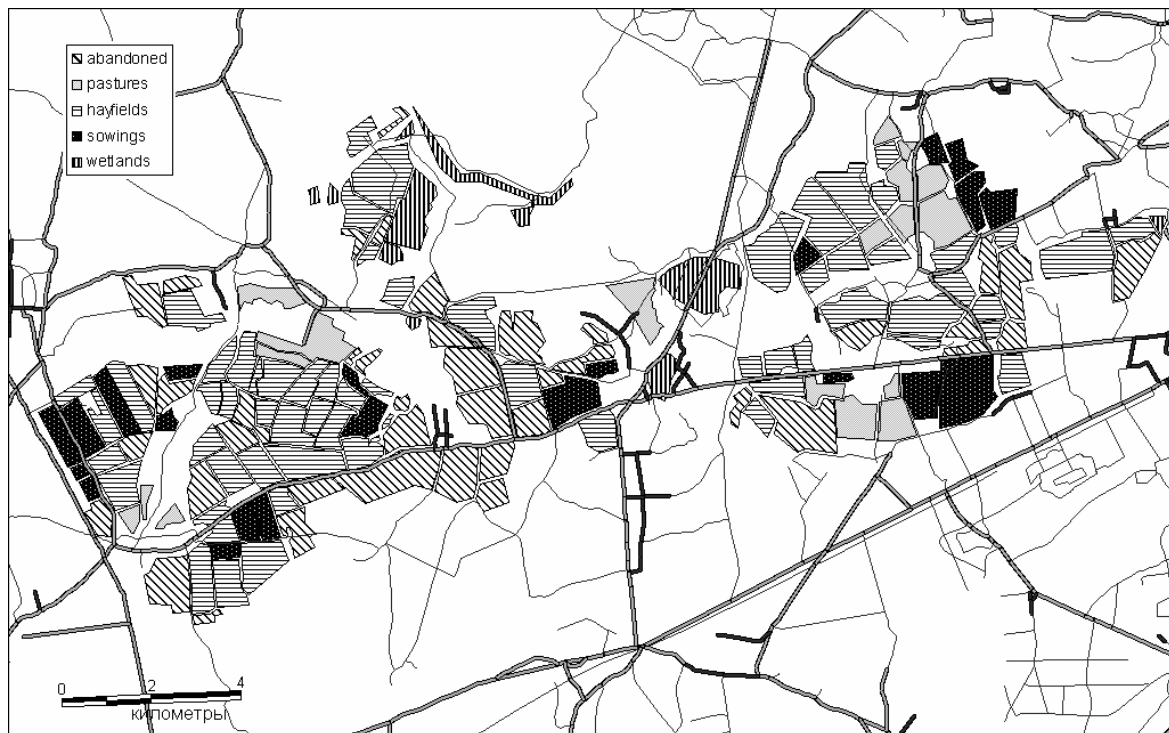


Figure 1. Study area map.

In total, we made 472 registrations of Hen Harriers, 341 of Marsh Harriers and 98 of Montagu's Harriers hunting in different habitats.

To find out the role of a certain habitat in harrier foraging, the frequency of visits to each of the habitats distinguished and the hunting success there were determined. Since fields in the area form a mosaic – a barley field may lie between hayfields, an abandoned hayfield may adjoin a utilized one, a cut-over may neighbour hayfields – the hunting process was subdivided into time intervals within which the bird flew over a certain habitat. During the observations we recorded the duration of such time intervals of a hunting flight over a field of one type. When the type changed, a new stage in the hunt, i.e. a new time interval, began. If a hunt halted and was then resumed in the same field, the next stage of the hunt was considered as a separate hunting flight with its own temporal and other characteristics. When there were boundaries of plots within a habitat – roads, stone ridges, drainage ditches – and the bird just crossed them to continue hunting in the same habitat, it was considered the same time interval. Flights over drainage ditches overgrown with reeds or shrubs were classified as hunting in a natural habitat.

The number of attacks was also recorded. Schipper (1977) described the hunting technique of harriers as follows. A hunting bird would sometimes hover and then choose one of the three options: pouncing (onto prey), carefully inspecting a small (several m<sup>2</sup>) area, or chasing prey. It was the first scenario – pouncing onto prey (plummeting into grass) – that was classified as an attack.

The height and speed of the hunting flights were taken into account. Two categories were distinguished for the flight height: low – within 2 m above the ground or water, high – higher than 2 m; and for the speed: slow and fast flight. Both height and speed were determined by eye. Detailed records are available for 148 hunts by Marsh Harriers, 74 by Hen Harriers and 45 by Montagu's Harriers.

As regards hunting success, we distinguished 3 categories of hunts in the habitat:

“successful hunt” – time interval of a hunting flight over a habitat ending in prey capture,

“unsuccessful hunt” – time interval of a hunting flight over a habitat within which ineffective attacks were observed,

“cruising” – time interval of a hunting flight over a habitat when no attacks were made.

The hunting success was defined as the proportion of successful hunts in the total number of hunts in the habitat.

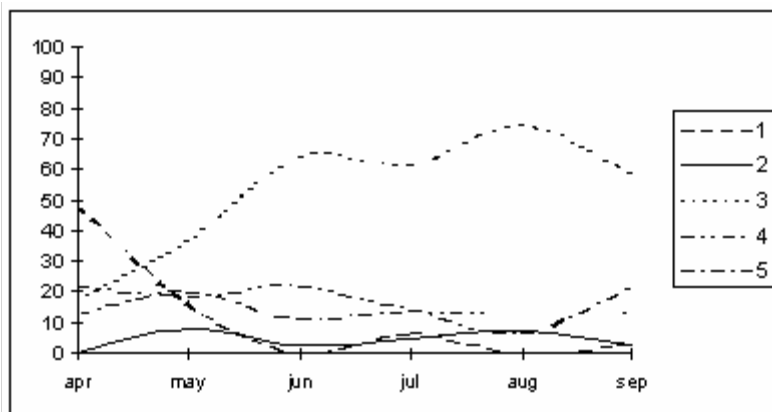
The hunting efficiency (capture success) of harriers in a habitat was defined as the ratio of the number of successful attacks (ending in prey capture) to the total number of attacks undertaken during all hunts in the habitat (Temeles 1986).

Sex differences in the choice of hunting habitats were analysed specifically in hunting grounds (not breeding grounds).

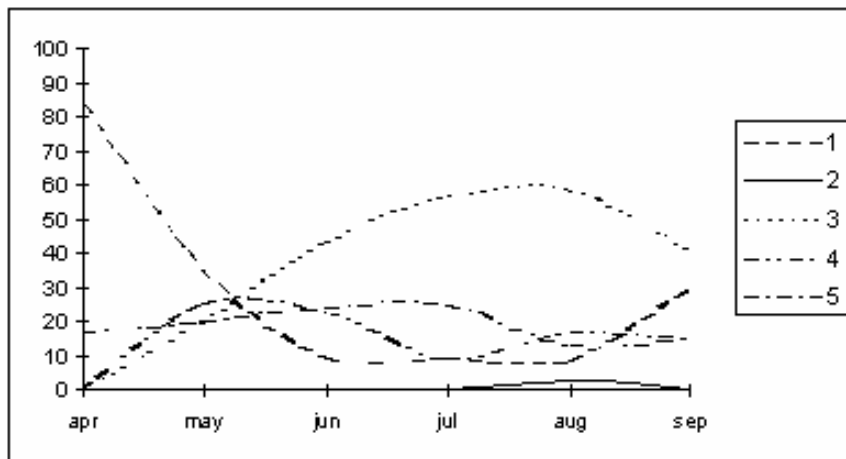
Reliability of differences in the frequency distribution of hunting birds among habitats was determined using the “chi-square” method. Statistical processing of the material was done using “Statistica-6” software.

## RESULTS

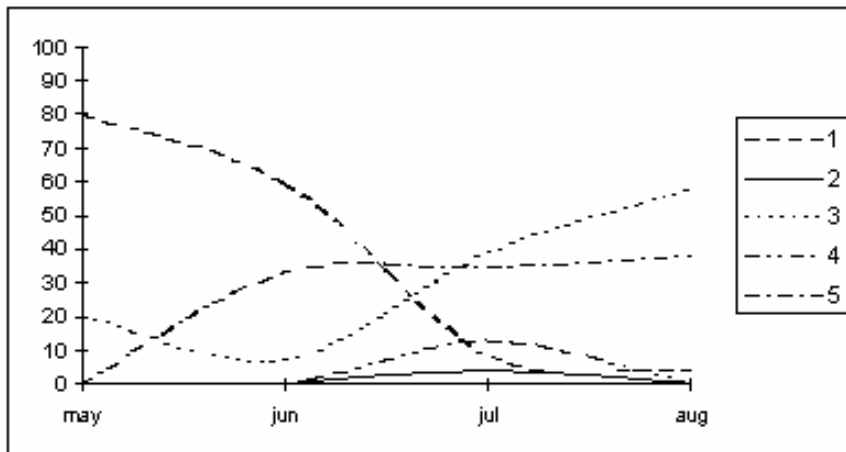
After arrival in spring, the Hen and Marsh Harriers spent most of the time in natural habitats. As soon as in May, however, they moved to dry low-grass habitats to stay there until departure. Utilization of high-grass habitats in hunting grew notably in September–October – in the migration period. Among the species in our study the Hen Harrier was most closely connected to hayfields, but it also inspected more actively all habitats in its breeding area (fig. 2). The Marsh Harrier also preferred hayfields, but spent more time hunting in high-grass habitats (more often in dry abandoned fields than in moist “natural” habitats) than the Hen Harrier (fig. 3). Montagu's Harrier also hunted in natural habitats early in the season. By the middle of the season it moved to dry high-grass habitats (fig. 4).



**Figure 2.** Hunting habitats of *C. cyaneus*. 1 – wetlands, 2 – sowings, 3 – hayfields, 4 – pastures, 5 – abandoned fields.



**Figure 3.** Hunting habitats of *C. aeruginosus*. Legend as in fig. 2.



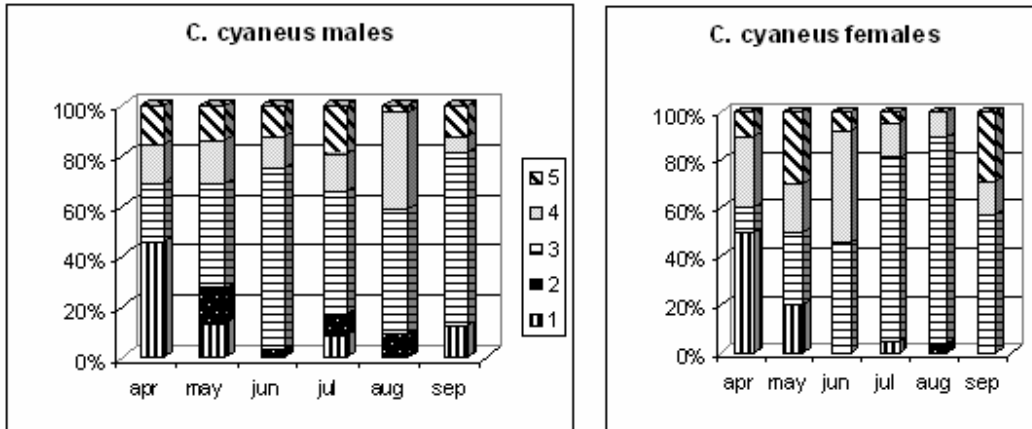
**Figure 4.** Hunting habitats of *C. pygargus*. Legend as in fig. 2.

Breeding and feeding grounds of breeding males may be quite far apart – a male may travel 1–4 km away from its nest for food. As soon as Hen and Marsh Harrier females started incubating eggs, males left for farmland; not a single male (n=12) hunted within the territory. Montagu's Harrier males hunted in nest areas during courtship, nest construction and egg laying (n=3). During the incubation period they started visiting farmland occasionally, but fields became the main hunting location only when chicks reached an age of 8–10 days.

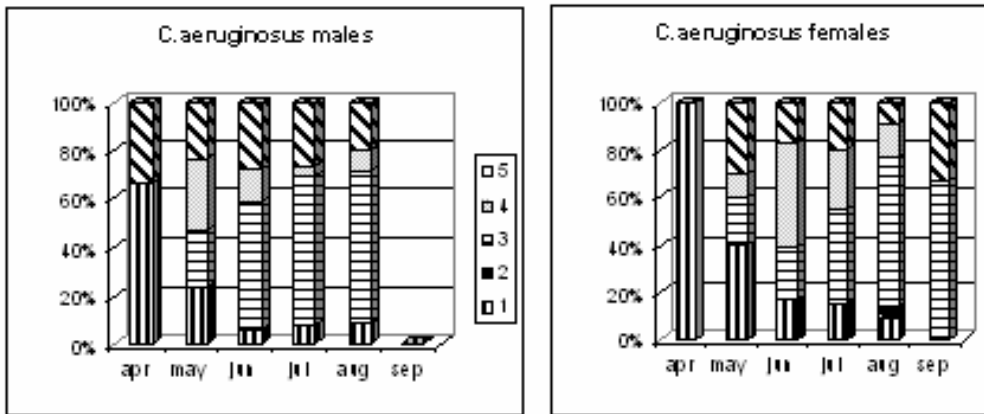
For the Hen and Marsh Harriers sex differences in the choice of habitats were obvious at the onset of the breeding season. In May, females hunted in abandoned fields more than males. In June, both males and females equally preferred low-grass habitats, but the proportion of pastures in the foraging activities by females was significantly (2–3 times) higher than by males (fig. 5 and 6). Montagu's Harrier females never hunted in pastures and sown fields (fig. 7). In August, females of all three species hunted nearly solely in hayfields.

After leaving their nest areas, fledglings of all species moved to stubble fields. 10–14 days after leaving the nest area, fledglings hunted almost exclusively in stubble fields, and it was only afterwards that they began inspecting adjacent higher-grass habitats. Thus, the proportion of high-grass fields in their hunting activities increased by the departure time (fig. 8–10). Connection to stubble fields was stronger for Hen Harriers and weaker for Montagu's Harriers.

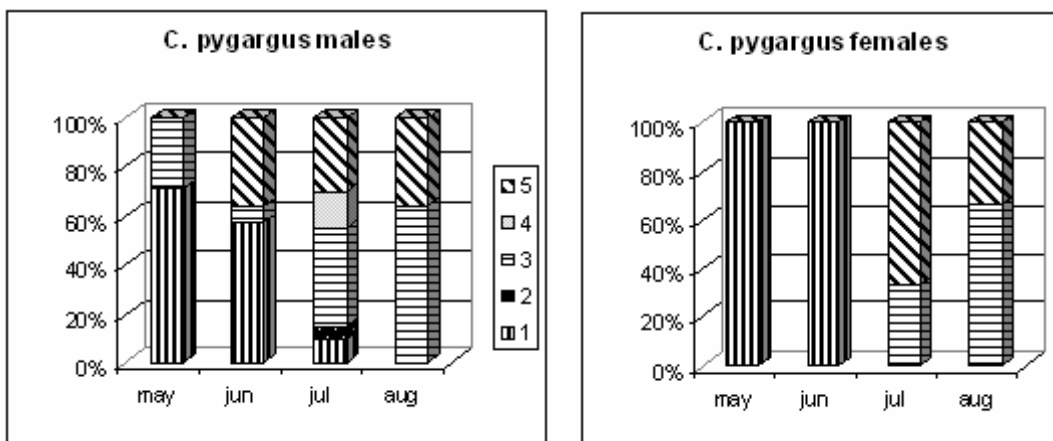
The abundance of rodents increased in the course of a season in all habitats (fig. 11), but their numbers were the highest in hayfields (both mown and abandoned). Rodent abundance was quite high in natural habitats, too. Prey abundance, however, increased simultaneously with grass height (fig. 12), and it was only in hayfields that its increase ceased at some point (no rodent trapping was made in pastures). When hay mowing began, one could easily see that among hayfields, adult Hen Harriers chose stubble fields, whereas Marsh and Montagu's Harriers preferred hunting along the stubble/tall grass edge.



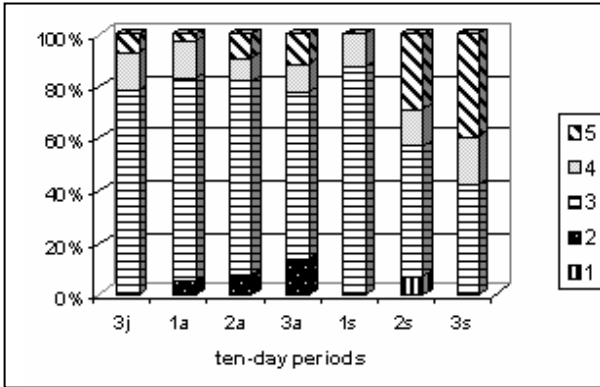
**Figure 5.** Sex differences in *C. cyaneus* hunting habitat choice. Legend as in fig. 2.



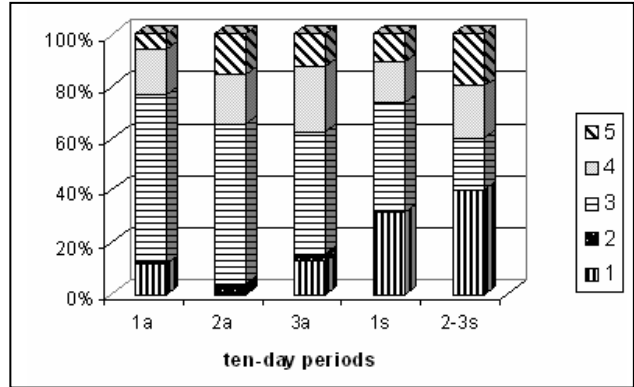
**Figure 6.** Sex differences in *C. aeruginosus* hunting habitat choice. Legend as in fig. 2.



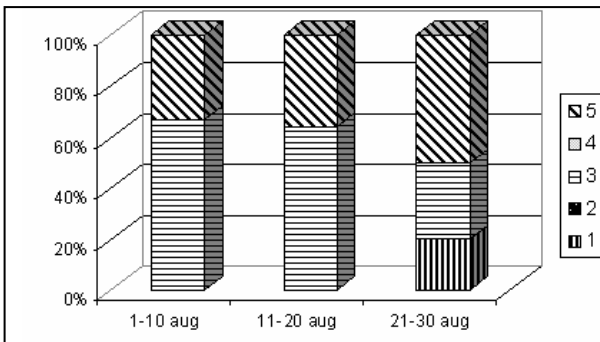
**Figure 7.** Sex differences in *C. pygargus* hunting habitat choice. Legend as in fig. 2.



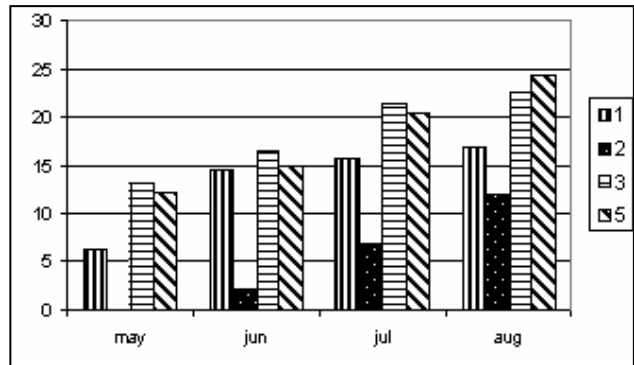
**Figure 8.** Hunting habitats of young Hen Harriers. Legend as in fig. 2.



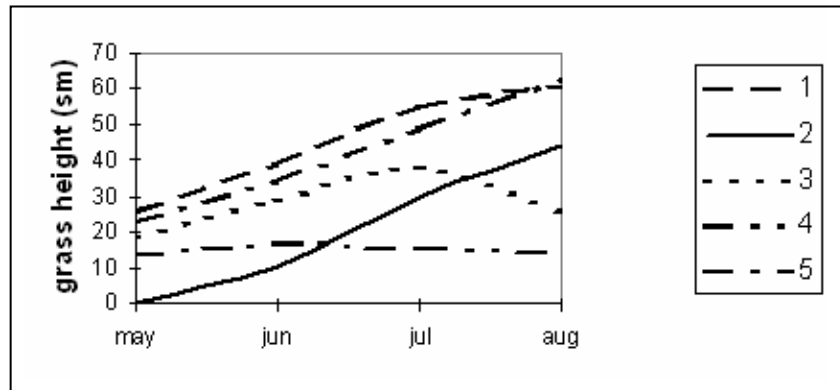
**Figure 9.** Hunting habitats of young Marsh Harriers. Legend as in fig. 2.



**Figure 10.** Hunting habitats of young Montagu's Harriers. Legend as in fig. 2.



**Figure 11.** Comparative abundance of rodents in different habitats. Legend as in fig. 2.

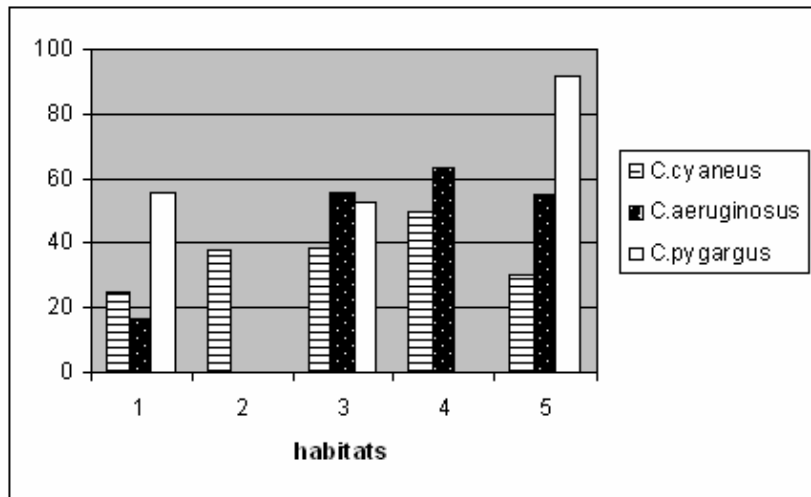


**Figure 12.** Seasonal changes in average grass height in different habitats. Legend as in fig. 2.

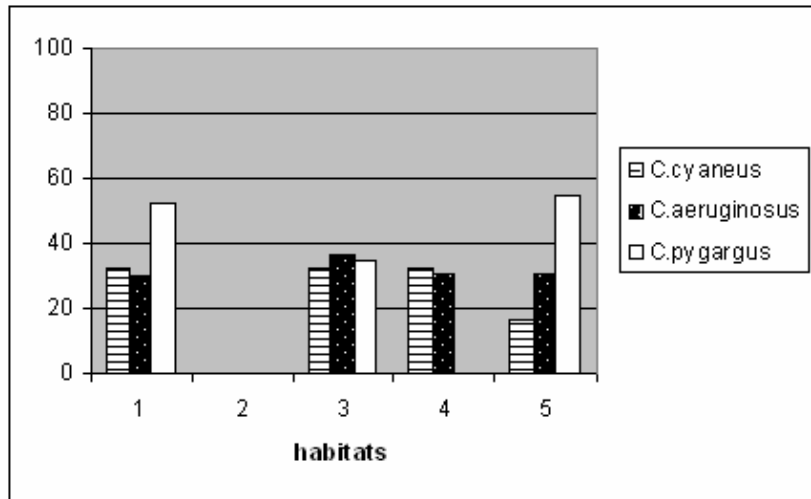
Generally speaking, hunting success was the highest in the Montagu's Harrier, and the lowest in the Hen Harrier. The proportion of "cruising" was the highest in the Hen Harrier.

In natural habitats, the most successful hunters were Montagu's Harriers, the least successful, strange as it is, Marsh Harriers. Marsh Harriers were more successful than others in hayfields and pastures, Montagu's Harriers in abandoned fields (fig. 13).

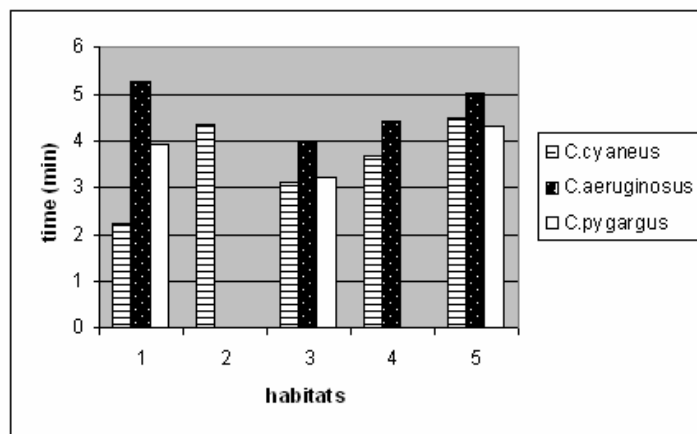
The hunting efficiency ratio was the same (fig. 14): Montagu's Harriers were the most efficient hunters in natural habitats and abandoned fields, Marsh Harriers in hayfields. In pastures, Hen Harriers hunted less successfully but more efficiently than Marsh Harriers (the former capturing prey at a first or second attempt and the latter at a second to fourth attempt). The duration of hunts in pastures was also somewhat longer in Marsh than in Hen Harriers (fig. 15).



**Figure 13.** Hunting success in different habitats. Legend as in fig. 2.



**Figure 14.** Capture success in different habitats. Legend as in fig. 2.



**Figure 15.** Average hunting duration in different habitats. Legend as in fig. 2.

The average duration of Marsh Harrier hunts was the longest in natural habitats and the shortest in hayfields. Its hunting flights were the longest of all the harrier species in all habitats in general. Hen Harrier hunts in natural habitats were the shortest, as well as more efficient and successful than those of Marsh Harriers. Abandoned fields turned out to be the optimal hunting habitat for Montagu's Harriers. An average hunt in this habitat took them a little longer than in other habitats, but the success and efficiency of their hunting there were the highest compared to other habitats and other harrier species (fig. 13, 14).

Statistically reliable selectivity was found in the distribution of hunting birds among habitats. The

Hen Harrier chose hayfields and pastures, avoiding other habitats. The Marsh Harrier also showed reliable preference for hayfields and pastures. Montagu's Harrier ignored sown fields and pastures giving preference to high-grass habitats (tab. 1).

Statistical processing of the data revealed no reliable differences in the height and speed of flight in different habitats. Montagu's Harriers appear to fly higher and faster, but quantitative data to support this statement are insufficient. The hunting flight of Hen and Marsh Harriers was most often low and slow in any habitat. However, the Hen and Marsh Harriers hunted more successfully from low and slow flight, whereas Montagu's Harrier from high and slow flight.

**Table 1.** Distribution of hunting harriers among biotopes in the breeding season.

	Natural habitats	Cereal fields	Hayfields	Pastures	Abandoned farmland	No farmland
No of biotopes of the type	9 (5.8%)	23 (14.7%)	63 (40.4%)	18 (11.5%)	43 (27.5%)	156
Area of biotopes of the type (km <sup>2</sup> )	8	18.5	50.5	16	35	
<i>C. cyaneus</i>	27 (5.7%)	24 (5.1%)	289 (61.2%)	71 (15%)	61 (12.9%)	472
<i>C. aeruginosus</i>	46 (13.5%)	3 (0.9%)	171 (50.1%)	55 (16.1%)	66 (19.4%)	341
<i>C. pygargus</i>	21 (21.4%)	1 (1%)	41 (41.8%)	3 (3%)	32 (32.6%)	98

## DISCUSSION

Many of the studies into species and sex differences in habitat preferences of harriers approached the problem from the point of view of food specialization (Temeles 1986, 1987, Schipper 1973, 1977, Simmons 2000). In our study area, no clear food specialization was revealed for harriers during the breeding season (see Introduction). The Marsh Harrier in Europe is the most "reeds-related" bird. It hunts predominantly in moist high-grass habitats. Its food range is, however, quite wide there, whereas the choice of habitats is not so rich. The same is true for the Hen Harrier. The Marsh Harrier preys on larger and less mobile quarry in reed stands. Montagu's Harrier takes the smallest and most mobile prey in dry natural habitats (Schipper 1973, 1975, 1977, Simmons 2000). Judging by the descriptions provided, neither of the study areas of these authors had fields analogous to our hayfields. In addition to wetlands, harriers in Europe hunt in cereal fields. In our conditions they obviously prefer hayfields to both cereal fields and habitats with a natural vegetation succession. Only Montagu's Harrier, although spending much time in hayfields, still prefers high-grass habitats like abandoned fields and reed beds. The proportion of hayfields in our study area is far greater than that of any other type of farmland. Besides, hayfields, both mown and abandoned ones, have a feature essential for *Mi-*

*crotus voles* – the sod layer. Shepel' (1992) also reported of the Hen Harrier in the Perm region hunting in farmland and moving to stubble fields as they became available. Montagu's Harrier in the Perm region hunts in the same type of habitats as in the Leningrad region, but it uses also spring crop fields – a situation observed in our area only once in all three study seasons. The reason may be that hayfields (both mown and abandoned ones) are much more numerous in the study area than cereal fields. Prey abundance, too, is far higher in the former than in sown fields.

The Hen Harrier hunting success was the highest in pastures. It was quite high also in hayfields and abandoned fields. For the Marsh Harrier it was the highest in abandoned fields; then follow hayfields and pastures, where it is only slightly lower. Montagu's Harrier hunted most successfully and efficiently in abandoned fields, preferring this habitat to all others. All the three habitats essentially represent permanent swards with a thick sod layer, which is a crucial precondition for *Microtus voles*, harriers' main food during the breeding season.

Why do Hen and Marsh Harrier females in June spend more time hunting in pastures than males? This is the month of active grass growth. Hay mowing begins not until in the second half of July, and the only low-grass habitat in June is pastures. Schipper's (1973, 1977) studies in northern Europe have shown that females at the beginning of the breed-



ing season prefer high-grass habitats. Since these studies deal with breeding birds, and females during the breeding season are limited to the nest area, their hunting activities are also confined to the area, which is normally a high vegetation habitat. In our study, females hunting in the fields were non-breeding ones. They were thus not limited in the use of the territory and had a freedom of choice. As females of the species are larger than males, heavier and less manoeuvrable, it must be easier for them to hunt in low-grass habitats. Both males and females of Montagu's Harrier equally prefer tall-grass habitats in this period.

Sex differences in habitat choice in August are probably due to stronger connection of females to the brood. For this reason, they hunt in hayfields where their young are. Males can fly over a wider area and really do so.

After leaving the natal nest areas, fledglings move readily to stubble fields. Young Montagu's Harriers begin exploring tall-grass habitats somewhat earlier, and wetland habitats slightly later than other habitat types; young Hen Harriers are altogether unwilling to do that, staying linked to low-grass fields until departure. Migrating juvenile Hen Harriers are, however, more often seen in tall-grass and scrub habitats: in reeds along water-bodies and overgrown drainage ditches.

## CONCLUSION

During the breeding season, all the three harrier species in our model area preyed on *Microtus voles*.

The preferred habitats of Hen and Marsh Harriers during the breeding season were hayfields, those of Montagu's Harriers abandoned fields.

After leaving their natal nest areas, broods of all three species always moved to stubble fields.

When hunting outside their territories, females of the Hen and Marsh Harriers chose lower-grass habitats than males.

The hunting success in the Hen Harrier was the highest in pastures. It was, however, quite high also in hayfields and abandoned fields. In the Marsh Harrier, the hunting success was the highest in abandoned fields; then followed hayfields and pas-

tures, where it was only slightly lower. Montagu's Harrier hunted most successfully and efficiently in abandoned fields, preferring this habitat from all others.

The hunting efficiency in the Hen Harrier was the highest in hayfields and pastures, in the Marsh Harrier in hayfields, in Montagu's Harrier in natural habitats and abandoned fields, respectively.

Generally, the most successful hunter was Montagu's Harrier. The Marsh Harrier hunted more successfully than the Hen Harrier. The hunting success of the Hen and Marsh Harriers was higher at low and slow flight. Montagu's and Marsh Harriers preferred hunting over taller grass than the Hen Harrier.

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