

Jerzy SOSNOWSKI¹⁾ and Sławomir CHMIELEWSKI²⁾

Breeding biology of the Roller *Coracias garrulus* in Puszcza Pilicka Forest (Central Poland)

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Abstract. Observations of breeding behaviour and checks on nests (N=99 nests) were made in 1957–1972, 1979–1982 and 1990–1993. The first date of arrival at the breeding grounds was to some extent correlated with mean May temperatures ($r_s=0.7674$, $p=0.001$). Nest clusters of up to 5 pairs were observed in especially favourable habitat conditions, but nestboxes placed within breeding grounds were seldom occupied. As observed previously, nest material was not carried in, although bits of shiny objects were sometimes found. Observations of birds arriving in couples suggest that pair bonding starts on the wintering grounds. Differences in the egg-laying dates of different pairs can be as great as 30 days. There was a strong positive correlation between the mean June and July temperatures and the number of fledglings reared by successful pairs ($r=0.7460$, $p=0.05$). Nesting success was strongly negatively correlated with average rainfall for July ($r=-0.8124$, $p=0.05$). The long-term mean for the number of young leaving a nest per successful pair was 1.8 (N=44).

Key words: Roller *Coracias garrulus*, breeding ecology, breeding behaviour, territorial behaviour, diet

¹⁾Bardowskiego 4/24, 97–200 Tomaszów Maz. POLAND

²⁾Rynek 12, 05–640 Mogielnica, POLAND

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INTRODUCTION

In Poland, the Roller *Coracias garrulus* is one of the species showing decreased abundance and even the threat of extinction (Głowaciński 1992). In Central/Eastern Europe, the site furthest west where the species occurs more abundantly is Poland's Puszcza Pilicka.

However, the Roller's biology and ecology are the subjects of relatively few original publications in the literature. Besides older work of a general nature (Dementiev & Gladkoff 1951, Heinroth & Heinroth 1966 and Sokołowski 1972), mention can be made of the handbooks of Glutz & Bauer (1980) and Cramp (1985). Detailed information on selected aspects of the biology and ecology of the species is also to be found in

the works by Wigsten (1955), Szijj (1958), England (1963) and Frisch (1966) and Haensel (1966).

STUDY AREA

Puszcza Pilicka takes in the central drainage basin of the Pilica River in Piotrków province (51°30'N, 20°15'E). This highly-fragmented forest complex lies on both banks of the river and covers an area of 52,000 ha. Within the Puszcza, some 82% of the forest is of pine, with alder carr — accounting for 8% — occurring in valley depressions. Pine is the dominant species, with young stands occupying most (all but 12.3%) of the area. Non-forest areas used in agriculture are taken up

mainly by rye and potatoes. For the purposes of the experiment a 216 km² central area representative of the whole complex was selected (Fig. 1). This area was 65.4% forest, 21.1% arable land, 8.1% meadows and pastures and 5.4% urbanized. The human population density in the area amounted to 88.7 per km².

aggregation of several pairs (a loose colony) which involved 3–5 families occupying an area of about 20 ha within the test area singled out.

Observations of the colony were carried out by 2–3 people working in shifts from the early hours of the morning until dusk. Other sites within the test area had

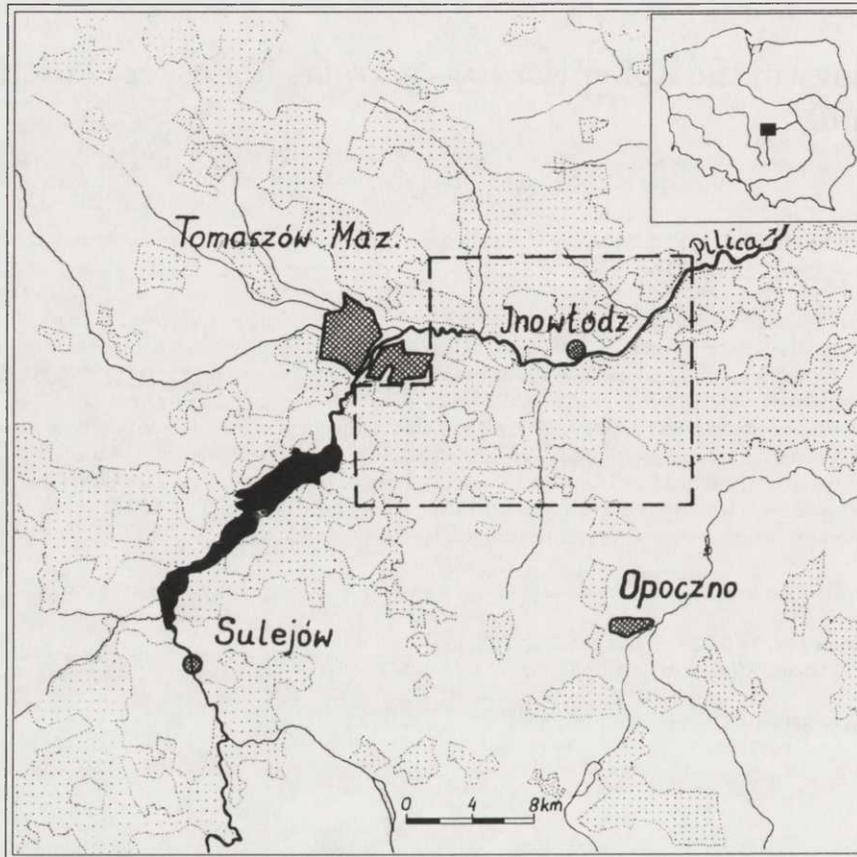


Fig. 1. The sample plot within the overall study area.
[Ryc. 1. Obszar badań i granice powierzchni próbnej w Puszczy Pilickiej.]

MATERIALS AND METHODS

Data has been collected with limited intensity since 1957. However, between April 25th and August 15th in the years 1969–1972, more intensive research was carried out on a forest area of about 150 km². In turn, in the years 1979–1982 data on selected breeding sites of Rollers was collected once more. The aforementioned 216 km² test area was observed intensively in the years 1979–93. This area held 11–28 nesting pairs in the years 1969–1992, but particular attention was paid to an

the contents of their tree holes tested a few times in the initial phase of incubation, but it was often just the degree of occupation of nestboxes that was checked. The contents of tree holes were checked with the aid of a mirror. Boxes were put up in the second half of April each year, and tree holes were cleaned out in the post-breeding periods of some years in order to obtain data on dietary composition and nest construction. The ringing of nestlings was carried out in the years 1991–1993.

RESULTS AND DISCUSSION

Arrival

After their arrival, rollers were quiet and relatively immobile — especially where they occurred at single sites (pairs). In contrast, those in colonies were already active the second day after their return. There were nervous flights from place to place in the area around tree holes occupied in the previous season, as well as short-duration courtship flights.

Spring arrivals were drawn out in time. There was a link between the date of first appearance and the mean May temperature ($r_s=0.77$, $p=0.001$, $N=20$). The earliest arrivals took place on April 22 1969 and April 24 1990, while the latest were noted in the period May 17–25 (and accounted for more than 30% of all observations ($N=43$)). The mean arrival dates are within those given for the country by Tomialojć (1990) and for Silesia by Dyrzcz et al. (1991).

Observed throughout almost the whole of May were occasional relocations of single birds or pairs, and even groups of 3–5 individuals, which remained in place for a short time before disappearing from the given area. Their flights were in a NE direction. During the observations carried out in the areas occupied by the colony it was noted that the arrival of each pair occurred at other times to those of neighbouring pairs. The onset of laying also began at times set apart by 15–25 days at times (mean=20).

Territory

In the Puszcza Pilicka area, the Roller occurred in areas with extensive agriculture on sandy soils on the edges of areas with trees, or else within tree stands by clearcuts or unused areas which constituted the usual feeding places. Sites near clearcuts were of short duration, because the Roller requires areas with low vegetation for feeding (Glutz & Bauer 1980, Cramp 1985, authors' observations). Such areas become overgrown in just 5–6 years with grasses up to a metre high which make it impossible for the Roller to feed.

63% of nests were situated at the forest edge ($N=98$), while 21% were among meadows with trees, 10% in trees in the middles of fields and only 6% within forests more than 300 m from the edge.

The occupation of breeding territory was mainly accomplished by pairs. The arrivals of single birds

were observed 7 times in 38 observations. These showed limited activity and weak responses to sound stimulation from a tape recorder. They were probably non-breeding birds or individuals which had lost their mates. The arrival of a single bird and the continued presence in the area of just 1 individual through the breeding season usually indicated the abandonment of the given breeding site in the following season. On the basis of 11 years of continuous observation it was noted that places providing conditions for the nesting of breeding pairs were occupied for many years. Sometimes concentrations of several pairs (colonies) were created. According to Dementiev and Gladkova (1951), this is brought about by a lack of suitable breeding places. Four types of concentration were noted in Puszcza Pilicka in the years 1957–1992. By the 1990s there persisted only one site where 3–5 pairs nested in an area of about 20 ha. Other sites had a maximum of 2 pairs per 10 ha. In the literature, mentions of nesting in loose groups or small colonies were made by Glutz and Bauer (1980) and Cramp (1985). The smallest distance between occupied nest holes was 80m ($\bar{x}=173$ m, $SD=85.7$, $N=9$). The colonies mentioned here mainly disappeared as a result of the felling of tree stands.

Aggregations of pairs were probably created from a primary site around which other satellite sites appeared and disappeared. These sites were in general of short duration, probably occupied by young birds. The most permanent were primary sites and their destruction brought about the disappearance of the entire colony. Examples of primary sites and the birds associated with them were constituted by sites in the forestry districts of Żądłowice, Dąbrowa, Januszewice and others, where Rollers had been noted for over 30 years.

The feeding area

In relation to the diversity of biotopes this may have various sitings in relation to the breeding territory and be of varying size. In Puszcza Pilicka the area furthest from the nesting hole was recorded at a distance of 2300m. Glutz and Bauer (1980) and Cramp (1985) cite distances of as much as 3000m. The feeding area around the nest occupied an area of several tens of ares, while areas beyond the breeding territory involved several permanent patches covering 15–25 ha

and used consecutively in the course of a given year. Only 3 of the 23 feeding areas were joint ones used by pairs nesting close together. Observations of such jointly-used areas did not reveal either intraspecific or interspecific aggressive behaviour from Rollers. Other species of birds often observed in these areas including Kestrels *Falco tinnunculus*, and Great Grey Shrikes

forestry district of Smardzewice. Up to 1972 there was a site in area later flooded by the creation of the Sulejowski Reservoir. After the flooding of the breeding site a new site was noted on the other side of the reservoir, but during the period of feeding nestlings a Roller flew to the former site many times — covering a distance of 2300 m over the water.

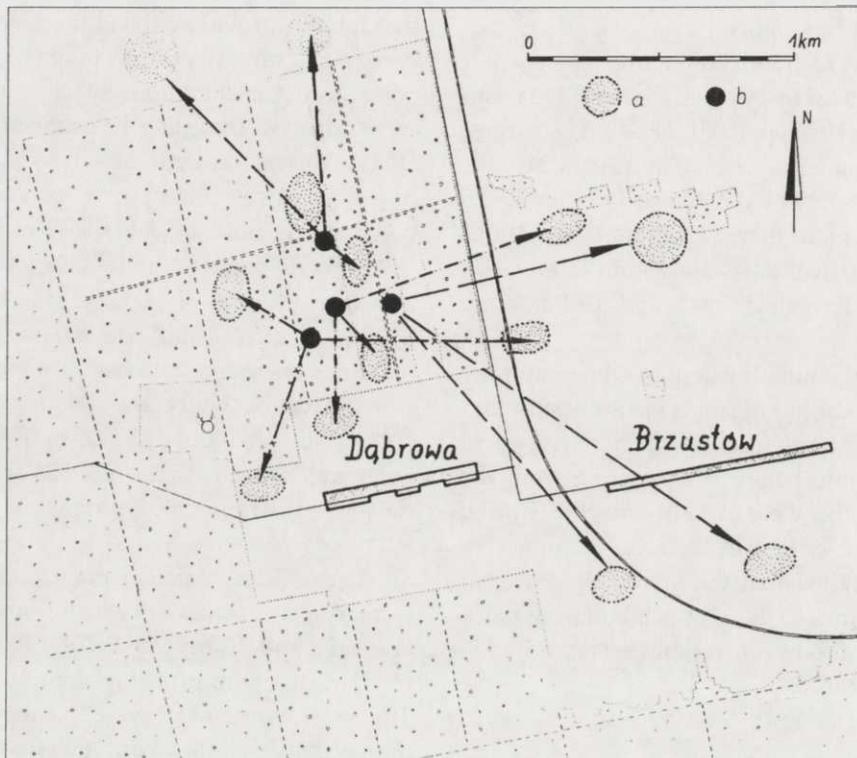


Fig. 2. Non-conflict distribution of feeding areas in a colony of Rollers; a — foraging area, b — nesting place.

[Ryc. 2. Niekonfliktowe rozmieszczenie żerowisk w kolonii kraski; a — żerowisko, b — dziupla.]

Lanius excubitor, were not mobbed by Rollers. An association between Rollers and a given feeding area was not the only one recorded, for birds also had preferences for particular perching places (posts, wires and trees) from which they hunted. Glutz and Bauer (1980) cite similar behaviour. The period preceding the laying of eggs saw Rollers generally make use of the feeding places found near their breeding places and tree holes. On the other hand, in the later period up to the moment of departure they fed alternately in more distant areas (Fig. 2). An interesting example of attachment to a feeding area is a Roller site in the

The nest

Rollers mainly (in 79% of 52 cases) used tree holes abandoned by Black Woodpeckers *Dryocopus martius* or Green Woodpeckers *Picus viridis* (11%). The use of holes in decaying trees was also noted (10%). Beyond forests, this type of tree hole occurs in willows, poplars and birches, and more rarely in field pear trees (Tab. 1). According to Glutz and Bauer (1980) and Cramp (1985), the Roller most often occupies tree holes in pines and oaks. In Pilicka Forest, trees with tree holes in managed forests were generally removed. Rollers most often used the same tree hole for 3–4 years (Tab. 2).

According to Malcevskij and Pukinskij (1983), the period of use of tree holes is longer. The Roller is considered a species of limited effectiveness in fights for nest sites with Starlings *Sturnus vulgaris*, Hoopoes *Upupa epops* or even Tits *Parus sp.* (Glutz & Bauer 1980). However, in Puszcza Pilicka, the Roller was seen to

often E- or NE-facing (Fig. 3). However, the orientation of Roller holes may result not from choice but from the fact that Woodpeckers orientate their holes in such a way. Trees with holes were most often situated on the margins of forests, in old tree stands. Holes found 100–150 m from the edge of the forest accounted for 9%

Table 1. Location of nests.

[Tabela 1. Umieszczenie gniazd.]

Nest site	N	%
<i>Pinus sp.</i>	57	57.7
<i>Salix sp.</i>	19	19.2
<i>Populus sp.</i>	5	5.0
<i>Alnus sp.</i>	4	4.0
nest boxes	4	4.0
<i>Cerasus sp.</i> , <i>Pisus sp.</i>	3	3.0
<i>Betula sp.</i>	3	3.0
<i>Quercus sp.</i>	2	2.0
buildings	1	1.0
escarpment	1	1.0
Total	99	100.0

prevail against other bird species — removing the eggs or nestlings found there. In the 9 noted cases, it was Tits that were expelled 5 times, Starlings twice and a Wryneck *Jynx torquilla* and a Hoopoe on the two other occasions. Such aggressiveness from Rollers was observed where a Roller had been the occupier of the tree hole in the previous season. In spite of the existence of many other holes in the nearest vicinity, Rollers preferred those which had been defended by neighbours of their own species and other potential competitors. Strong competition for tree holes between Starlings and other native birds was described by Howell (1943), Flux and Flux (1992) and Zerhusen (1992). Besides Starlings, Hoopoes, Wrynecks and Tits, holes suitable for Rollers were also occupied by Hornets *Vespa crabro* (N=6), Red Squirrels *Sciurus vulgaris* (N=4) and Pine Martens *Martes martes* (N=3). Holes occupied by Rollers in forests were at a minimum height of 6 m, with 70% being at between 8 and 12 m above the ground. The lowest occupied hole in an agricultural landscape was found at a height of 1.6m. The mean height of holes for the whole area was $\bar{x}=9.0\text{m}$ (SD=3.4, N=61). The hole entrance was most

Table 2. Period of utilization of nestholes, including those whose use was ended by the felling of a tree ().

[Tabela 2. Czas użytkowania dziupli włącznie z tymi, których użytkowanie zakończone zostało wycięciem drzewa ().]

Period of utilization in years	1	2	3	4	5
Number of nests	6	7	8	4	–
	–	(2)	(2)	(2)	(1)

the total (N=61) and were usually in tree stands interspersed with clearings or fragments of fallow land. Holes made by Black Woodpeckers had depths of 35 to 60 cm ($\bar{x}=43.1$, N=26, SD=7.2) while entry holes had mean dimensions of 8x12cm. Natural holes, as well as those after Green Woodpeckers, most often occurred

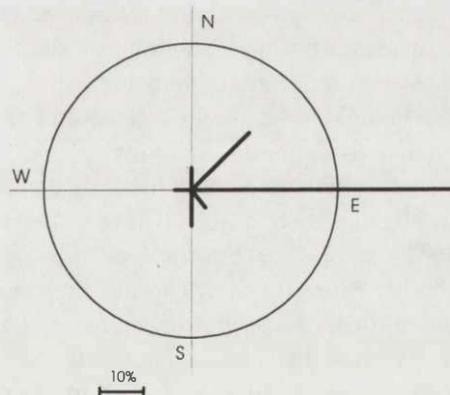


Fig. 3. Percentage of nest-holes exposed to particular globe quarters (N=61).

[Ryc. 3. Rozkład procentowy ekspozycji zajętych dziupli.]

beyond forest areas, having more varied dimensions and locations. Among about 80 nestboxes distributed across the sample plot only 4 were used for 2–3 seasons. These boxes were only used on territories already previously occupied by Rollers. In other areas they did not represent an incentive to colonization. In comparison, of the 56 incidences of breeding by Rollers analyzed by Hudec (1983), 9 occurred in nestboxes.

The observed phenomenon of a change of occupied holes every 3–4 years may be justified by the fact that the Roller does not expel its faeces, and its dry mass in the course of one breeding season may occupy about 1 dm³ where there are three nestlings! In such a situation, the filling of the nest proceeds relatively rapidly, and the process may be accelerated by the accumulation of material in the hole by other birds. Faeces expelled by nestlings sinks into mould, drying out to create a powdery ash-grey mass. The brown colouration of faeces in the hole may derive from the brown stomach contents which disturbed nestlings expel into the hole (Glutz & Bauer 1980, authors' data). Powdery faeces provides a home for mites *Acari spp*, for lice *Mallophaga spp* and for the larvae of the mealworm beetle *Tenebrio molitor*. The dry mass of faeces deriving from three nestlings weighed about 500–800g. Some handbooks (Dementiev & Gladkov 1951, Gotzman & Jabłoński 1972, Aulak 1989) have it that the Roller lines its nesthole. Our data show that the species lays its eggs directly on to the wood or onto faeces piled up from the previous year. This took place also where holes (N=27) were specially cleaned with a new lining before the breeding season. On the other hand, very few thin sticks or grass stems were found, or else single pine needles. These did not give the lining of the nest any structure. Also found in nestholes were pebbles, pieces of bark, bottle-tops, corks, pieces of glass and crockery. The function of these items is unknown.

Rollers may alternatively nest in sandy banks, crags and even abandoned buildings (Glutz & Bauer 1980, Hudec 1983, Cramp 1985, Stastny 1987). On the Greek island of Kos, Samwald (1995) found that nearly all nests were in earth cavities in cliffs and steep banks. In the years 1985 and 1986, in the area of Inowłódz nad Pilica, Rollers were found to breed in abandoned colony of Sand Martins *Riparia riparia*, in the area of a disused aggregates quarry. The entrance hole was enlarged to a diameter of c. 10 x 10 cm and was found c. 30cm below the surface of the scarp. In the two years, 2 and 1 young birds respectively flew from the nest. In Poświętno near Inowłódz a nest of Rollers was found in a disused building. The nest was situated in the curves of the attic of a residential building. Not far away (at about 400 m), there were several empty nest holes in old pines.

Breeding behaviour

Glutz & Bauer (1980) stated that the forming of pairs in the Roller only occurs after arrival at and occupation of a breeding territory. In turn, however, there is another view that bonding occurs in the African winter quarters. The authors observed that the two birds of a pair appeared on the breeding territory simultaneously in 31 out of 38 cases. Arrivals of single birds (in 18% of cases) probably involved sexually immature birds or those who had lost their mates. Pairs arriving back in places occupied in previous years showed an interest in nestholes shortly after their arrival — i.e. on the second or third days. Two types of behaviour were observed here. At sites where a nesthole had already been occupied (e.g. by starlings), pairs not resigning from the initially occupied territory found other empty holes in the vicinity. In this case courtship flights took place at several places. The second type of behaviour manifested itself in aggressive attacks on the intruder. These were not always effective and were linked with clear interest in previously-used nestholes only. In addition to courtship flights there appeared an incessant, nervous flying from branch to branch in the vicinity of the nesthole and the issuing of "growling" cries. Shortly after their arrival at the breeding site, Rollers behave quietly and secretly, keeping silence for the first 2–3 days with the exception of occasional contact calls. In contrast, if they are already in the vicinity of another pair they become very noisy, making courtship flights and typical courtship calls.

Courtship flights are engaged in most intensively in the period prior to egg-laying. Later they are rather less well-marked, though may be performed in the view of a neighbouring pair. The females also take part in such flights. In the course of the courtship flight, the male ascends to 50–100m and beating sharply with his wings descends steeply, inclining his body violently from one side to the other while producing a crescendo of "croaking" calls. The flight usually ends on the top of a tree or a protruding branch. Flights were sometimes engaged in by several pairs simultaneously. The courtship flight described was observed in breeding territories through almost the whole season. Besides its basic function of indicating the limits of the territory it also served as an expression of a bird's state of mind. It was noted that males which had repelled a rival or a

representative of another species from the area of the nesthole indulged in a kind of "triumphal" flight (similar to the courtship flight).

It was also noted that birds returning from feeding grounds immediately engaged in a courtship flight of short duration within their territories. Such behaviour has also been observed on autumn migration routes (Cramp 1985). Shortly after arrival from the wintering grounds, representatives of breeding pairs group together in small areas quite close together and engage in courtship-type flights every so often. Shortly after the flight of one had been provoked, the next took flight and soon returned to the perch in a calmer state. Aggressive behaviours were not observed among them. This type of encounter did not disturb the attentive observation of the birds' own breeding territories and their active defence against intruders. Encounters were of limited duration and were observed at the beginning of the period of occupying territory. In colonies, courtship flights even continued after young birds were able to fly, but rather more limited activity was observed among pairs nesting singly. Courtship flights were engaged in with the same intensity among pairs which did not go on to breed. It was noted that single birds sometimes appeared at breeding sites. These did not engage in breeding, but showed an interest in a given place. They associated for several weeks with the holders of the territory but did not infringe the boundaries of the defended area. Observations were even made of attempts to enter a nesthole during the period that nestlings were being fed. Intruders were however scared away.

A constituent element of courtship preceding the laying of eggs is the "greeting" ceremony. This involves deep bows rather reminiscent of the courtship movements of the Collared Dove *Streptopelia decaocto*. Cramp (1985) referred to this as the greeting of the female. Greeting between Rollers was also observed in other situations: prior to copulation and following the dramatic reaction of two birds to the presence of a Black Woodpecker. On the third day after occupying territory, a male sitting on the edge of a nesthole performed bows in the presence of a female, flew down to the ground carrying an object of unestablished shape and came to the hole at whose entrance it repeated the greeting ceremony.

A characteristic feature of nuptial behaviour was the entering of the nesthole by the male, followed by the female. This took place in the period prior to the laying of eggs. It was not always the hole in which eggs were laid that was involved and indeed it was noted that birds not engaging in breeding could also perform the same nuptial ritual. This ceremony of "pointing out" a potential nest site had a stimulatory effect upon other birds, inducing a courtship reaction. The ceremony of entering the nesthole lasted throughout June and even into the incubation period. Similar behaviour was observed several times from individuals which were not successful. A confirmation may be the observed reaction of a male Roller who responded to the sighting of a Black Woodpecker in the vicinity by calling suddenly and quickly entering a nearby nesthole, and even a nestbox occupied by bats *Chiroptera sp.*

Some pairs were seen to copulate in the first third of July, and thus in the period in which young were being fed. On July 16th 1991, a copulating pair were seen sitting near a nesthole. Similarly, in Puszcza Kozienicka, a pair was observed copulating on July 20th 1993 near a nesthole with young (information from S. Wąsik).

According to Wigsten (1955), courtship feeding usually only occurs after the selection of the nesthole for breeding and during the egg-laying period. Our data show that feeding took place both before the laying of eggs and also later. The presentation of food to the female was often observed in the final phase of incubation, the first days of feeding and even after the period of sitting.

Broods

Rollers probably reach sexual maturity in their second year of life (Glutz & Bauer 1980, Cramp 1985). Pairs have been observed occupying territory but not laying eggs. Territories were defended both by pairs and by single individuals. The laying of eggs was recorded as early as at the end of May. The majority of pairs began breeding in the first third of June and sometimes even in the second third of this month (Tab. 3). Time differences in the periods of laying amounted to as much as 26 days. The earliest laying was reported on May 18th 1982 and the latest on June 12th 1984. Females laid eggs at 48-hour intervals, or in

extreme cases every 3 days. Cramp (1985) made the same observation. In the years 1962–1984, 29 holes were monitored with a view to determining the size of clutches (Tab. 4). The mean per nest was found to be 3.59 eggs. The authors' own observations combined with the literature show that incubation begins in the period that the last egg is laid (Glutz & Bauer 1980, Cramp 1985, authors' own data). According to other authors it begins once the first egg has been laid (Gotzman & Jabłoński 1972, Hudec 1983).

was noted that both sexes devoted equal time to incubation, although some authors (Wigsten 1955) have claimed that the role of the female is dominant. A greater share of incubation time from the male was noted in periods of bad weather. The authors' own observations show that the male spends a significant amount of his time near the nesthole maintaining voice contact with the female from time to time. In areas more intensely penetrated by people, the bird behaves more secretly and quietly. At this time even active

Table 3. Times of arrival and the onset of the incubation of eggs (in parenthesis), on the basis of five exemplary breeding sites in Dąbrowa forestry district in the years 1990–1992.

[Tabela 3. Terminy przylotów i rozpoczynania wysiadywania jaj (w nawiasach), na przykładzie pięciu miejsc lęgowych w leśnictwie Dąbrowa w latach 1990–1992.]

Year	Number of the hole				
	1	2	3	4	5
1990	6 V (-)	12 V (4 VI)	22 V (-)	24 IV (20 V)	16 V (9 VI)
1991	2 V (8 VI)	14 V (-)	17 V (1 VI)	-	7 V (30 V)
1992	7 V (-)	12 V (3 VI)	1 V (-)	29 IV (-)	-

None of the monitored clutches revealed the crushed eggs which would have indicated disruptions to the calcium balance in the birds. There were no statistically-significant differences between the periods 1969–72, 1979–82 and 1990–93 in terms of the brood results for nests in which young hatched (Tab. 5, Fisher Test $p > 0.05$).

Table 4. Sizes of clutches in the years 1962–1984, N=29.

[Tabela 4. Wielkość zniesienia w latach 1962–1984, N=29.]

Clutch size	2	3	4	5	Σ	\bar{x}	SD
Number of clutches	2	11	13	3	29	3.59	0.78
%	7	38	45	10	100		

It was noted that Rollers did not leave eggs even when disturbed. For example, when tree-felling led to the cutting of a tree with an incubating Roller, the bird only flew from the nesthole when the tree hit the ground. Similar behaviour was noted in the course of checks on nestboxes. Birds did not react to the opening of boxes, leaving them only after re-closure.

Incubation lasted 17–20 days (N=9, \bar{x} =18.3, SD=1.0). Nestlings hatched between mid-June and mid-July. It

defence of the breeding territory takes place in silence. However, some males react violently and noisily. The sighting of a person in the vicinity of the nesthole provokes the same reaction as is shown towards another species of bird posing a threat, which is to say dramatic courtship-type flights and harsh crescendos of calls. Before leaving incubated eggs, the female gives short contact calls from the edge of the hole which she leaves after hearing a response from the male. Females usually fed near the nest, though they sometimes left the territory for periods of 5–20 minutes. Sometimes a female would leave the nest without making contact with the male, but in this case feeding took place nearby.

Newly-laid eggs weighed 12–14g (\bar{x} =13.6, SD=0.54, N=11). Newly-hatched nestlings had a mass of around 10g (\bar{x} =10.1, SD=0.22, N=9). It was noted that growth and the putting-on of weight by nestlings proceeded at different rates. Differences in the ages of nestlings from a single nest were clear in almost every clutch, and the oldest nestling often attained twice the size of the youngest. Breeding success recorded in the years 1969–1972 and 1979–1982 (Tab. 5) was very similar (Fisher Test, $p > 0.1$). The years 1990–1993 witnessed a fall in breeding success compared to the two previous

periods, and this was particularly clear when comparisons concerned the proportion of nests from which young flew (a statistically-significant difference, Fisher Test, $p=0.03$). Of 29 broods analyzed, 6 were found to have lost single nestlings and 4 the entire brood. Dead nestlings did not show clear signs of injury. It was noted in four cases that the loss of broods had been brought about by martens *Martes sp.*. Studies carried out in the years 1977–1992 pointed to a link between breeding success and atmospheric conditions in the period.

A close link was noted between the mean temperature in June and July and the number of young raised per pair in intact nests ($r=0.7460$, $p=0.05$, $N=9$). There was an inverse relationship with the mean precipitation for July. Longer periods of heavy rain were shown to have a negative influence on the number of young raised with success per pair ($r=-0.8124$, $p=0.05$, $N=9$). Also noted were the negative influences of enduring

Care of offspring

In the first period after hatching the main burden of caring for the nestlings fell on the female. It is not possible to state whether food brought by the male is given directly to the young or again via the female (Glutz & Bauer 1980). It was noted that males came with food to females sitting in nestholes and also many times that the two birds went in in succession. In periods of bad weather and cold it was the male that was mainly responsible for feeding, while the female remained longer in the nest keeping the nestlings warm. At these times, food was given to the female at the nest opening, although the male sometimes entered for a short time. The breaks in feeding around midday described by Glutz & Bauer (1980) were not observed. The frequency of feeding took different forms even in the same weather conditions, with the same number of nestlings of similar age. Between 6.00 and 7.00 in the morning feeding occurred at the rate of 5–6 visits per

Table 5. Breeding success.

[Tabela 5. Sukces lęgowy.]

Nests:	Number of nests			
	1969–1972	1979–1982	1990–1993	Σ (%)
— with eggs	28	19	11	58 (100)
— with eggs destroyed during incubation	2	1	3	6 (10)
— in which young hatched	26	18	8	52 (90)
— in which young hatched but did not fly	3	1	2	6 (10)
— in which at least one fledgling flew	23	17	6	46 (80)

drought, very high temperatures and limited precipitation on breeding success in 1992. Of 6 monitored pairs which went on to breed only 3 raised young ($\bar{x}=1.0$ young bird per pair). The long-term mean for the 44 broods analyzed was 1.8 young per pair, leaving the nest. This result is similar to the 1.5 young per pair from Creutz (1979) for the period of the population decline observed in West Germany. On the other hand, this author gave a figure of 3.2 young per pair for “good” years. Observations made by members of the forest services and others show that pine martens *Martes martes* cause significant losses.

Only four cases of repeat breeding (usually the laying of 2 eggs) were noted. From these birds raised one young bird on two occasions.

hour, while between 13.00 and 14.00 the number of visits rose to 20. A fall in the frequency of visits was observed in the early evening hours. A certain indication of the frequency with which young birds were fed prior to leaving the nest is given by the following observations: July 27th, 10.00–19 visits per hour, July 29th, 09.00 — 11 visits per hour, July 30th, 10.00 — 6 visits per hour, August 1st, 11.00 — 4 visits per hour (the day of the flight of the first bird). Extremely variable behaviour was observed. The frequency of feeding in the early evening hours on the day of flight rose dramatically to 14 visits per hour. The above observations may not be treated as rules on account of the incompleteness of the results gathered.

In the first days after hatching, nestlings remained quite, not calling at all. Soft calls were only given 12–14

days after hatching. In the final stages of feeding they became ever louder, but birds only gave voice at the time the feeding bird approached the nest. Otherwise they generally remained silent. In the presence of people near the nest the birds reacted by refraining from feeding, flying nervously from branch to branch at a distance of 20–30m from the observer. Birds leaving the nesthole kept silent. Nestlings disturbed in the nest reacted by way of defensive reflexes involving the expulsion of brown stomach contents. In the feeding period, both birds actively defended the territory. They sometimes tolerated the nearby nesting of Kestrels, but never displayed such tolerance towards Hobbies *Falco subbuteo*. They reacted particularly distinctly to sightings of Goshawks *Accipiter gentilis* or Common Buzzards *Buteo buteo*. Restlessness was also shown in relation to Black Woodpeckers.

On the day the first young bird left the nest, feeding ceased almost totally. Admittedly, it was noted that the parents brought food, but that for long periods it was not given. This was associated with calling by both the male and female. Nestlings seeking to leave the nesthole usually perched on the edge of the hole, extending their wings and inclining their bodies quite far down. The flights of nestlings from the nesthole lasted 2–4 days. Nestlings leaving the hole made use only of a gliding flight, usually landing on the ground or a low tree. One of the parents took care of the first to fly out, maintaining voice contact with it. The remains of young birds were noted many times in the vicinity of nestholes. After leaving the nest, the young birds flew around in a small area around the hole, gradually distancing themselves more and more from it. However, the parental pair continued to defend the nest territory actively. In general the young birds remained quiet or kept in contact with their parents by way of soft calls. The further from the nesthole the young birds went, the more their contact with their parents declined. Feeding events became rarer to the point where they eventually ceased altogether. This took place between 10 and 14 days after the leaving of the nest. In areas with strong anthropopressure, the young birds distanced themselves much more quickly and were found 2 kilometres from the nest after only 8–10 days. In areas less penetrated by people the family groups spread out less, sometimes maintaining contact with the parents up to the point of autumn departure. Immediately after leaving the nest, the nestlings did not

show fear of man. The escape distance increased with development but was still less than in adult birds. In relation to people on foot it amounted to about 20m. The first nestlings left the nesthole at the beginning of the last third of July, while the last left around the middle of August. After gaining complete independence, the young birds were sometimes observed on perching places with their parents, even in far-distant areas. Rydzewski (1949) mentioned a ringed fledgling 30 km from the site after some 19 days.

Food

Rollers hunt from places which are also resting sites. The favoured places from which to hunt are power lines or dry, dead branches below the crowns of trees. Prey are most often caught on the ground, with the bird usually returning quickly to the same place. Birds are also capable of hunting prey on the ground by making several hops. Larger prey items are struck against a branch or thrown in the air and swallowed. On July 4th 1992, 9 Rollers were observed hunting for flying ants along with Kestrels. This took place in the early evening and lasted for about 3 minutes. Similar events were observed on July 10th 1992, when 5 Rollers joined 3 Kestrels. The flights in this case resembled the feeding of Swallows *Hirundo rustica*. The Roller is thus capable of hunting for insects while in flight. Such a method of feeding on emerging flying ants has also been observed on the wintering grounds (Glutz & Bauer 1980).

Food was taken whole to the young. In the food taken in Puszcza Pilicka, a dominant role was played by medium-sized insects augmented to a very limited extent by small amphibians and reptiles, and more rarely by small mammals (see Tab. 6). In the population nesting in the study area the composition of the diet was only estimated on the basis of analysis of faeces and regurgitated pellets. The pellets of adult birds measured 10x20–25mm and weighed 2.8–3.3g. Pellets and faeces contained undigested chitinous parts of insects, mainly beetles. Some information was obtained by observing adult birds carrying food in their bills. As in other areas of our geographical zone (Szijj 1958, Haensel 1966, Malcevskij & Pukinskij 1983, Cramp 1985), the main constituents of the food were beetles *Coleoptera* spp., grasshoppers and allied insects *Orthoptera* spp., dragonflies *Odonata* spp., hymenopterans *Hymenoptera* spp and *Lepidoptera* — mainly caterpil-

lars. Small vertebrates were a minor addition — Sand Lizards *Lacerta agilis*, frogs *Rana* spp., small toads *Bombina* spp. and shrews *Sorex* spp. Also recorded was the bringing to the nest of small vertebrate prey items exceeding the ability of the young birds for direct consumption. Examples of such food items included small grass snakes *Natrix natrix* and larger frogs.

Table 6. Composition of the Roller's diet in Puszcza Pilicka in the breeding season. Numbers of prey items in sample are given, faeces N=11, pellets N=57.

[Tabela 6. Skład pokarmu kraski w okresie lęgowym w Puszczy Pilickiej. Podano liczbę ofiar w próbie, kał N=11, wypluwki N=57.]

Prey	Faeces	Pellets	Total	%
<i>Spondylis buprestoides</i>	61	25	86	20.0
<i>Geotrupes stercorosus</i>	37	14	51	11.9
<i>Arthropulus rusticus</i>	32	9	41	9.5
<i>Chrysobothris chrystostigma</i>	28	12	40	9.3
<i>Carabus sycophanta</i>	14	13	27	6.3
<i>Ergates faber</i>	18	8	26	6.1
<i>Cicindela campestris</i>	24	—	24	5.6
<i>Cetonia aurata</i>	6	4	10	2.3
<i>Carabus violaceus</i>	3	2	5	1.1
Coleoptera total			310	72.1
<i>Barbitistes constrictus</i>	14	11	25	5.8
<i>Psophus stridulus</i>	21	2	23	5.4
<i>Tetrix bipunctata</i>	16	4	20	4.7
<i>Oedipoda coerulescens</i>	9	8	17	4.0
<i>Podisima pedistis</i>	11	3	14	3.3
<i>Gryllus campestris</i>	4	6	10	2.3
<i>Tetigonia viridissima</i>	3	—	3	0.7
Orthoptera total			112	26.2
<i>Anura</i> sp. (juv.)	—	3	3	0.7
Amphibia total			3	0.7
<i>Lacerta</i> sp.	1	1	2	0.5
<i>Natrix natrix</i> (juv.)	1	—	1	0.2
Reptilia total			3	0.7
<i>Sorex</i> sp.	—	1	1	0.4
Mammalia total			1	0.2

The most abundant species in the diets of Rollers in forests were *Spondylis buprestoides* and *Geotrupes stercorosus*. Food also included insects secreting toxic substances, although Colorado beetles *Leptinotarsa decemlineata* were not among them. In August, the species caught most frequently were grasshoppers etc.

Saltatoria spp., including *Barbitistes constrictus*, *Oedipoda coerulescens*, *Podisima pedistis*, and often also *Decticus* sp., *Psophus stridulus* and *Tetrix bipunctata* (Tab. 6).

Departure from the nesting area

On the basis of return information concerning ringed birds it is known that the Polish population migrates via the Balkans, Greece, Turkey and Egypt. The rate of movement is poorly known, with the only information concerning ringed birds recorded September 1st on Crete (Greece), September 6th in Anatolian Turkey, September 14th in Damietta (Egypt) and September 18th in the Alexandria area of Egypt (Rydzewski 1938, Szczepski 1951, data from the Gdańsk Ornithological Station). In the middle basin of the Pilica river the first individuals begin their migration in mid-August. The abandonment of territory was a drawn-out process. Observations of both territory-holding pairs and young birds suggest that the earliest departures involve birds which did not breed. Such departures usually took place in the middle or last thirds of August. The second group of departing birds were the young of the year, which were then followed by the breeding pairs themselves. It was seen that young remained to the time of departure of the parental pair, although their attempts to approach the parents were rebuffed energetically.

The earliest departures of adult birds took place in the first days of September, but the majority were noted at the end of the first third of that month. The latest departure dates recorded were September 25th–28th. Areas of varied landscape and hence probably of richer food supplies were associated with earlier departures, while less diverse areas with poor feeding areas were vacated later. Departures were significantly delayed in years characterized by longlasting summer droughts and high temperatures.

Translated by dr. James Richards

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1979–1982 i 1990–1993 na terenie Puszczy Pilickiej (ryc. 1).

Najwcześniejsze przyloty miały miejsce 22 IV 1969 i 24 IV 1990. Stwierdzono związek pomiędzy datą pierwszego pojawu a średnią temperaturą maja ($r_s=0.7674$, $p=0.001$, $N=20$). Najpóźniejsze przyloty stwierdzono 17 V 1991, 22 V 1990, 25 V 1984. Spośród 98 stanowisk kontrolowanych 63% było usytuowanych na skraju lasu, 21% — wśród zadrzewionych łąk, 10% — w śródpolnych zadrzewieniach, 6% — w głębi lasu do 300 m od jego skraju. Terytoria lęgowe były zajmowane na ogół przez pary (31 przypadków), ale również obserwowano nieco wcześniejszy (1–2 dni) przylot pojedynczego ptaka (7 przypadków). Przyloty pojedynczych ptaków mogły dotyczyć osobników nielegowych, bądź takich, które utraciły partnera, ponieważ w następnych latach zwykle obserwowano opuszczanie danego stanowiska lęgowego.

Tam gdzie istniały warunki do gniazdowania, kraski były przywiązane do określonej okolicy przez wiele lat, tworząc skupienia 3–5 par. Kraski najczęściej wykorzystywały dziuple po dzięciole czarnym 79% ($N=52$), dzięciole zielonym (11%) jak również dziuple naturalne (10%). Na 80 rozwieszonych skrzynek lęgowych modelu Sokołowskiego typu D tylko cztery były wykorzystywane przez 2–3 sezony. Znalezione też w kolonii brzegówek norę zasiedloną przez kraskę. Stwierdzono, że kraska potrafiła skutecznie walczyć o dziuplę. Na 9 zanotowanych przypadków, w 5 wygoniła sikorę, w dwóch szpaka a w pozostałych krętogłowa i dudka. Taką agresywność obserwowano gdy w poprzednim sezonie właścicielem dziupli była kraska która preferowała właśnie tę mimo, że w najbliższym otoczeniu były inne odpowiednie dziuple. Taka dziupla była też broniona przed sąsiadami własnego gatunku. Dziuple zasiedlane w lasach znajdowały się na wysokości minimum 6 m przy czym ok. 70% z nich znajdowało się 8–12 m nad ziemią. Najniżej położona zajęta dziupla w krajobrazie rolniczym znajdowała się na wysokości 1.6 m. Średnia wysokość umieszczenia zajętych dziupli dla całego badanego obszaru wynosiła ($\bar{x}=9.0$ m $SD=3.4$, $N=61$). Otwór dziupli najczęściej skierowany był na E lub NE (ryc. 3). Dziuple po dzięciole czarnym miały głębokość od 35–60 cm ($\bar{x}=43.1$, $SD=7.2$, $N=26$). Sucha masa kału po trzech piskletach zajmowała objętość około 1 dm³ i ważyła około 500–800g. Kraski nie usuwały kału, zatem po 3–4 latach następowało wypełnienie dziupli wy-

STRESZCZENIE

[Biologia lęgów kraski w Puszczy Pilickiej]

Puszcza Pilicka, zwana też Lasami Spalskimi, jest najdalej na zachód wysuniętym stanowiskiem licznego występowania kraski w Europie środkowosłobodniej. Materiał zebrano w latach 1957–1972,

schniętym kałem. Kraski nie znosiły materiału wyściółkowego i jaja składały wprost na próchnie. Rozpylony kał w dziupli był siedzibą roztoczy *Acari ssp.*, wszołców *Mallophaga ssp.* i larw mącznika młynarka *Tenebrio molitor*.

Wkrótce po przylocie na stanowisko lęgowe ptaki zachowywały się skrycie przez pierwsze 2–3 dni, wydawały jedynie głosy kontaktowe. Jednak jeśli były już inne pary w pobliżu — zachowanie było bardziej hałaśliwe. Ptaki w terytorium wykonywały loty tokowe i odzywały się tokowymi głosami. Na stanowiskach gdzie istniały skupienia kilku par loty tokowe miały miejsce nawet po uzyskaniu lotności przez młode. Składanie jaj stwierdzono już w końcu maja. Większość par przystępowała do lęgów w 1 dekadzie czerwca (tab. 3), a niekiedy w 2 dekadzie tego miesiąca. Średnia wielkość zniesienia wynosiła 3.59 jaja (tab. 4). Świeżo zniesione jaja ważyły 12–14 g ($\bar{x}=13.6$, $SD=0.54$, $N=11$). Świeżo wyklute pisklęta miały masę ok. 10 g ($\bar{x}=10.1$, $SD=0.22$, $N=9$). Obserwowano liczne przypadki strat w gniazdach jak też po wykluciu. Stwierdzono brak statystycznie istotnych różnic (test Fishera, $p>0.05$) w liczbie gniazd w których wykuły się młode między okresami 1969–1972, 1979–1982 i 1990–1993 (tab. 5). Sukces stwierdzony w latach 1969–1972 oraz w latach 1979–1982 był bardzo zbliżony (test Fishera, $p>0.1$). W latach 1990–1993 w porównaniu z obu poprzednimi okresami zaznaczył się spadek procentu gniazd z których wyleciało przynajmniej jedno młode (różnice istotne statystycznie, test Fishera $p=0.03$). Stwierdzono związek pomiędzy średnią temperaturą czerwca i lipca a liczbą młodych wyprowadzonych na parę z sukcesem ($r=0.7460$, $p=0.05$, $N=9$). Odwrotną zależność stwierdzono w powiązaniu ze średnią opadów lipca ($r=-0.8124$, $p=0.05$, $N=9$). Liczba młodych na parę opuszczających dziuplę wynosiła 1.8 młodego ($N=44$). Stwierdzono zaledwie cztery przypadki powtarzania lęgów.

W Puszczy Pilickiej najdalej znajdujące się od dziupli żerowisko stwierdzono w odległości 2300 m.

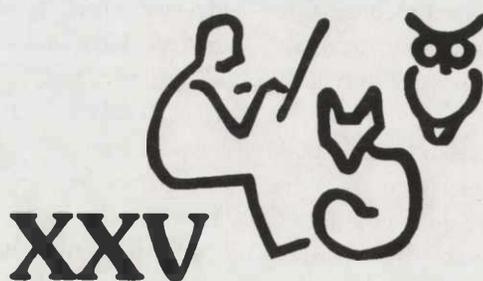
W pobliżu gniazda teren żerowiskowy wynosił kilkadziesiąt arów, natomiast poza terytorium lęgowym było to kilka stałych obszarów o wielkości 15–25 ha wykorzystywanych na zmianę w ciągu danego roku (ryc. 2). Na 23 żerowiska obserwowane tylko 3 były wspólnie wykorzystywane przez gniazdujące w pobliżu pary. W okresie poprzedzającym składanie jaj kraski wykorzystywały na ogół żerowiska znajdujące się w pobliżu miejsca lęgu. Natomiast w okresie późniejszym, aż do momentu odlotu żerowały przeemiennie na terenach bardziej oddalonych. Pokarm dla młodych przynoszony był w całości. Podstawowym składnikiem pokarmu kraski były chrząszcze *Coleoptera ssp.* (tab. 6). W środkowym dorzeczu Pilicy pierwsze osobniki rozpoczynały migrację w połowie sierpnia. Najwcześniej odlatywały osobniki które nie podjęły lęgów, następnie ptaki młode i wreszcie pary lęgowe. Najpóźniejsze daty odlotów to 25–28 IX.

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Correspondence address:

XXV IEC Wiener Medizinische Akademie (WMA)

Alser Strasse 4, A-1090 Vienna, Austria

phone: +43-1-405 1383-21; fax +43-1-405 1383-23

e-mail: Medacad@via.at

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