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RUSSELL THORSTROM, *The Peregrine Fund, 566 West Flying Hawk Lane, Boise, Idaho.* *Received 6 March 1996, accepted 20 Aug. 1996.*

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Production of erythristic eggs by the Black-headed Gull in Poland.—Egg erythrism is rare and most records in gulls, terns, skuas, and lapwings involve only single cases (Bates et al. 1976, Hays and Parkes 1993). Only three cases have been documented in the Black-headed Gull (*Larus ridibundus*) (Jourdain and Borrer 1914 after Bates et al. 1976). In our study, erythrism occurred rarely but more often than reported for other species of gulls and terns (Bates et al. 1976, Sutherland 1980, Hays and Parkes 1993).

The objectives of this research were to quantify erythrism in colonies of the Black-headed Gulls and to compare the egg-laying phenology, nesting location, clutch size, and hatching success of females laying typical and erythristic eggs.

Study area and methods.—Study colonies were on islands in the Vistula (Wisła) River between Dęblin and Kozienice, Poland. In 1986, three colonies were studied and were near Pawłowice village (51°36′N, 21°40′E), near Kuźmy v. (51°38′N, 21°33′E) and near Kobylnica v. (51°40′N, 21°35′E) (Table 1). In the years 1987–1988, only the two latter colonies were studied, and in 1989–1990 only the Kobylnica colony was monitored. The river islands, in contrast to stagnant water, are not the typical breeding sites of Black-headed Gulls. This habitat has been occupied for a short time (Bukaciński and Bukacińska 1993). Monitored islands were overgrown by grass and/or willow and poplar shrubs with bare sandy sections.

TABLE 1

THE FREQUENCY OF THE OCCURRENCE OF CLUTCHES WITH ERYTHRISTIC EGGS IN DIFFERENT COLONIES OF BLACK-HEADED GULLS

	Pawłowice			Kuźmy			Kobylnica		
Year	N[a]	N[b]	%[c]	N[a]	N[b]	%[c]	N[a]	N[b]	%[c]
1986	160	1	<1.0	100	4	4.0	385	16	4.2
1987	—	—	—	800	0	0	200	12	6.0
1988	—	—	—	550	0	0	100	6	6.0
1989	—	—	—	—	—	—	1200	14	1.2
1990	—	—	—	—	—	—	70	4	5.7

[a] Number of all clutches monitored.
[b] Number of clutches with erythristic eggs.
[c] Percentage of erythristic clutches.

Gulls occupied both sandy beaches and sections highly overgrown with grass. Erythristic clutches were found in both habitats.

Nests were marked with sticks and checked every 3–5 days from laying of the first egg to hatching. Thirty pairs were trapped while incubating on nests and individually marked (including 7 with erythristic eggs) (Bukacińska and Bukaciński 1993). The hatching success was determined only for 30 from 57 clutches with erythristic eggs. The remaining 27 clutches were collected for analyses of pesticides content. For some statistical analyses the data for all years were combined. We used Students *t*-test and χ^2 test.

Results.—The ground color of a typical egg of the Black-headed Gull usually is green or olive, but only rarely brownish, with blotches variously distributed, ranging from dark green to brown (Makatsch 1974). The background of erythristic eggs of the Black-headed Gulls on the Vistula River ranged from buff-yellow and cream-coloured to light pinkish and always with a distinct reddish shade. There were a lot of almost black or brown blotches, often framed with violet. The distribution of markings was uneven. They were often concentrated at the large end, creating a kind of ring or cap. Sometimes the cap reached half of an eggs' length. The other half of the egg was either slightly blotched with violet or dark greyish or even without markings at all. Eggs of particular clutches differed both in intensity of background color and in the size and number of blotches. Some eggs had thin shells (shells were soft and cracked).

Most of erythristic clutches were found in the "Kobylnica" colony (Table 1). In 55.8% of them, all eggs were reddish in color. In the remaining clutches, most often only one egg was erythristic and the rest were typical. Nest location in the colony had no effect on the frequency of egg erythrism. We noticed the clutches with erythristic eggs in 2.9% (N = 40) of nests situated in the center of a colony and in 2.1% (N = 12) of the nests at the edge.

Clutches with erythristic eggs were laid more often at the beginning of the breeding season (χ^2 = 58.3, df = 5, $P < 0.0001$, Fig. 1). Forty-eight percent of the clutches with erythristic eggs were laid during the first five days of egg laying in a colony. Later in the season the occurrence of erythristic eggs gradually decreased (Fig. 1). This pattern of egg-laying differed from that of typical eggs (χ^2 = 52.4, 26.7 and 37.8, df = 4, $P < 0.001$, in the years 1986-88, respectively). During the first ten days, typical eggs were laid in only 10.3–12.3% of nests, and they peaked between 10–15 and 15–20 days from the beginning (Fig. 1).

Three egg clutches had the lowest incidence of egg erythrism, and one egg clutches the

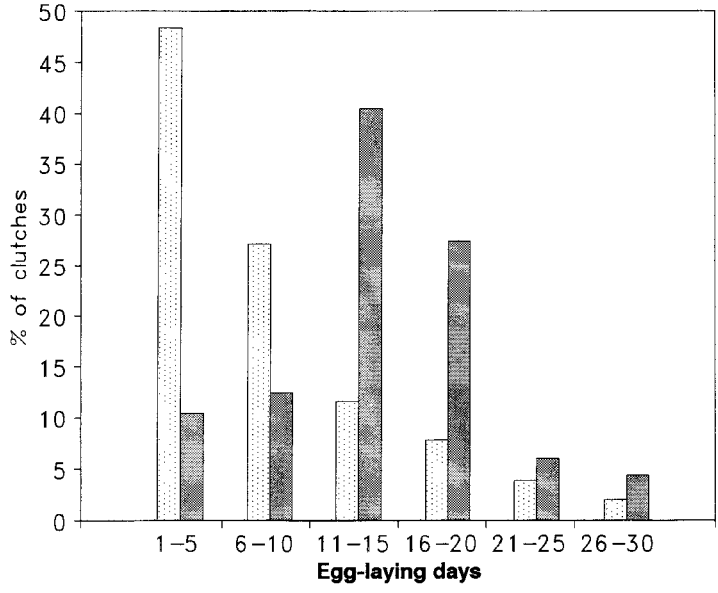

FIG. 1. Phenology of egg-laying in a Black-headed Gulls colony "Kobylnica" (time of laying first egg) in the years 1986–1990. OX axis "1" means the day of laying first egg in the colony. Dotted bars -erythristic clutches (N = 52), hatched bars—typical clutches (N = 494).

greatest (χ^2 = 60.5, df = 2, $P < 0.0001$) (Fig. 2). Clutches with erythristic eggs were smaller than clutches with typical eggs (t = 2.7, $P < 0.02$ and t = 2.0, $P < 0.05$ for 1986 and 1987, respectively) (Table 2).

Hatching success of clutches with erythristic eggs was lower than clutches with typical eggs (χ^2 = 5.7, $P < 0.02$ for 1986; Table 2). A higher percent of cracked eggs in erythristic clutches was the main cause of the lower hatchability (χ^2 = 23.7–166.3, $P < 0.0001$; Table 2), but even if cracked eggs were excluded from the analysis, the hatching success in erythristic clutches was still lower than clutches with typical eggs in 1988 (χ^2 = 4.2, $P < 0.05$).

Discussion.—Black-headed Gull colonies on islands of the Vistula River have a relatively high frequency (3% of nests, 57 clutches) of erythristic eggs compared to other studies (Bates et al. 1976, Sutherland 1980, Hays and Parkes 1993). The Vistula River is also the only place in Poland where that phenomenon has been reported. However, we do not know how to explain the high frequency of erythrism on the Vistula River.

The causes of laying erythristic eggs are unknown, although studies on Domestic Fowl (*Gallus gallus*) indicated that the color of eggs of individual females is genetically determined (Hutt 1949). Therefore it should be characteristic for individual females to lay similar eggs during their life. However, in colonies of the Black-headed Gulls we studied, only slightly more than half of the females that laid erythristic eggs laid clutches with all erythristic eggs.

Only two females (from seven individually marked) laid erythristic eggs every season. Three females that laid erythristic eggs laid typical eggs in successive years. We also found

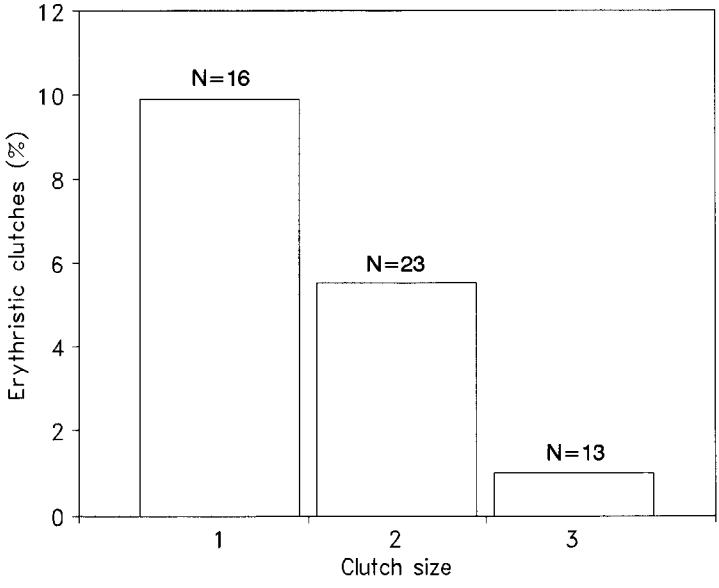

FIG. 2. The frequency of the occurrence of clutches with erythristic eggs within the clutches of different size.

TABLE 2

COMPARISON OF HATCHING SUCCESS OF ERYTHRISTIC AND TYPICAL CLUTCHES OF THE BLACK-HEADED GULL COLONY "KOBYLNICA" IN THE YEARS 1986–1988

Breeding parameters		Erythristic clutches	Typical clutches
Mean clutch size[a]	1986	1.86 ± 0.77 (14)	2.42 ± 0.14 (275)*
	1987	1.90 ± 0.74 (10)	2.37 ± 0.12 (192)*
	1988	2.16 ± 0.75 (6)	2.39 ± 0.11 (85)
Number of eggs laid	1986	26	660
	1987	19	463
	1988	13	184
Percent of cracked eggs[b]	1986	38.5 (10)	1.0 (5)**
	1987	52.6 (10)	1.5 (7)**
	1988	23.1 (3)	1.1 (2)
Percent of hatched eggs[b]	1986	34.6 (9)	54.8 (362)*
	1987	15.8 (3)	32.1 (151)
	1988	15.4 (2)	57.1 (105)

Number of nests or eggs given in parentheses.
[a] * $P < 0.05$, Student t-test.
[b] * $P < 0.05$, ** $P < 0.001$, χ^2 test.

the opposite situation -two females which had laid typical eggs in one year, laid erythristic ones in successive years. Mixed clutches of erythristic and typical eggs have been reported in two nests of the Glaucous Gull (*L. hyperboreus*) (Bates et al. 1976). Hays and Parkes (1993) reported one female Common Tern (*Sterna hirundo*) that laid erythristic eggs for four years and a typical one in the fifth. These cases suggest that the laying of erythristic eggs is not only genetically determined but that other factors affect whether they are laid, and how many in particular year (and successive).

Pesticides may be one of these factors. Recent unpublished studies of Łukowski et al. indicated increased level of pesticides in erythristic eggs. But the level was not high enough to change the color of eggs and cause the thickness of shell in large part of erythristic eggs (Table 2). The latter phenomenon was not described for erythristic eggs until now.

In poultry studies, there are viral diseases (IB: Avian Infections Bronchitis, EDS 76: Egg-drop-syndrome, Newcastle disease), bacterial diseases (Colibacteriosis), and fungal diseases (Mycotoxicosis) that result in periodic color abberations and changes of structure and thickness of the eggshell (Siegmann 1983, Borzemska et al. 1989). These diseases are also found in wild birds, including gulls (A. Kruszewicz pers. comm.). It may be that laying erythristic eggs is the result of both a genetic predisposition and condition of a female in a given year. This is supported by our results that show erythristic eggs are laid in smaller clutches and have a lower hatching success than typical eggs. The earlier time of laying of most of the erythristic eggs indicates they were laid by older birds which typically have large clutches and high success (Coulson and White 1958, Patterson 1965, Mills 1973, Ryder 1975). This could suggest that females laying erythristic eggs are not as healthy as females laying typical eggs (Coulson and White 1961, Winkler and Walters 1983).

In summary, we found that erythristic eggs were laid early in the season. The clutches were smaller with higher occurrence of cracked eggs and lower hatching success than typical clutches. All these indicate poor condition of females. However, we do not know all the factors which cause laying of erythristic eggs in a particular year. A more detailed study of marked females is necessary to help explain this phenomenon.

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DARIUSZ BUKACIŃSKI AND MONIKA BUKACIŃSKA, *Dept. of General Ecology, Institute of Ecology, Polish Academy of Sciences, Dziekanów Leśny, 05-092 Łomianki, Poland.* *Received 13 Oct. 1995, accepted 20 Sept. 1996.*

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Variable plumage ontogeny in the Black (*Turdus infuscatus*) and Glossy-black robins (*T. serranus*).—Ontogenetic sequences and their relative timing are a major issue of interest in ornithology (Lawton and Lawton 1985, Thompson and Leu 1994) and biology in general (Gould 1977). Attention has focused on relative timing, social implications, and evolutionary transformations in the ontogeny of plumage and soft-part color characters. A detailed understanding of causes and trajectories of these changes may allow inferences regarding a variety of evolutionary processes (e.g., Peterson 1991a, b).

Recently, during efforts to inventory the vertebrate fauna of Cerro Piedra Larga, a remote, isolated 2850 m massif in eastern Oaxaca, Mexico, we had the opportunity to study and sample abundant populations of the local Black Robin (*Turdus infuscatus*). During a two-week study period (31 March–13 April 1993), we observed about 15 individuals daily, and collected 16 specimens for detailed plumage comparisons. This material, together with specimens examined in the collections of the Field Museum (FMNH), Natural History Museum of Univ. of Kansas (KUMNH), and the Museo de Zoología, Facultad de Ciencias, Univ. Nacional Autónoma de México (catalogued temporarily as OMVP), permitted us to document further a poorly known male plumage (Baepler 1962, Howell and Webb 1995) in certain populations of this species. Additional information on specimens was kindly provided by the Louisiana State Univ. Museum of Natural Science (LSUMNS).

The majority of the specimens collected on Cerro Piedra Larga were males in an all-black plumage with a yellow bill (8), or females in a uniform brown plumage with a dusky brown bill (5). However, three males (OMVP 279, 282, and 439) had female-like plumage, pneumatized crania (100%, 80%, and 100%, respectively), and gonads that were not minute (testes 3 × 5 mm, 3 × 5 mm, and 7 × 10 mm, respectively); only one (OMVP 279) showed any sign of molt, and that described as "some under tail," and hence not illustrative in direct determination of plumage sequences. These males were dusky-brown plumaged with occasional black feathers scattered over the body, and tended to have duskier colored bills than the yellow-billed adult males. On several occasions, we observed brown-plumaged