Acta zool. cracov., **40**(2): 269-278, Kraków, 10 Dec., 1997

Breeding ecology of the Black-crowned Night Heron in Korea

Jae-Pyoung YU and Kyu-Hwang HAHM

Received: 10 Sep., 1995
Revised: 4 March, 1996
Accepted for publications: 26 Aug., 1996

YU J.-P., HAHM K.-H. 1997. Breeding ecology of the Black-crowned Night Heron in Korea. Acta zool. cracov., **40**(2): 269-278.

Abstract. Breeding ecology of *Nycticorax nycticorax* was studied in 1993 in the heronry situated near the Junam reservoir in Kyungnam Prov., Korea. 67 nests were built in *Pinus densiflora* and *Robinia pseudoacacia* trees; mean height of trees was 7.81 m and mean height of the nest sites above the ground was 7.29 m. The number of nests built in a given tree increased with the increasing breast height diameter of its trunk. The average sizes of nests were as follows: outer diameter 46.5 cm, inner diameter 22.3 cm, height 17.8 cm, depth 4.4 cm. One nest was made of 169-379 sticks. Full clutch consisted of 3-5 eggs, laid at 2 days' intervals. Elliptical eggs were spotless, pale bluish-green; their mean size was 50.8×35.0 mm and mean weight after laying 34.6 g. The incubation started with the first egg and lasted 22.4 days. The chicks' food consisted of fish (72% of items), insects (16%) and amphibians (12%). Hatching success: 90.91%, fledgling success: 53.33%.

Key words: *Nycticorax nycticorax,* nesting, eggs, nestlings, breeding success.

Jae-Pyoung YU, Kyu-Hwang HAHM, Environmental Research Institute, Kyungnam University, 449 Woryoung-Dong, Masan, Kyungnam, Rep.of Korea 631-701.

I. INTRODUCTION

The Black-crowned Night Heron *Nycticorax nycticorax* (LINNAEUS, 1758) is one of the 15 heron species in the Korean bird fauna. Its nominative subspecies breeds in warmer, temperate to tropical zones in the Palaearctic, Afrotropical and Oriental regions. The other subspecies live in North and South America. In Korea the Black-crowned Night Heron is a summer visitor; its breeding was reported from the southern part of the Kyonggi Province (WON 1981). More recently these birds have also been recorded from Shihung and Kimp'o in Kyonggi Prov., from Kimje in the Chollabuk Prov. and Muan in the Chollanam Prov. (Forest Research Institute 1992).

Since 1984 Black-crowned Night Herons have been observed on the Junam Reservoir in Tong-myon, Ch'angwon-gun, Kyungsangnam Prov. where they were found also in 1989 and 1990 (WON & HAHM 1984; HAHM 1984; HAHM & KIM 1993). The number of breeding birds in this locality increased annually, reaching 216 individuals in 1992 and 310 in 1993.

The breeding biology and ecology of the Black-crowned Night Herons have not been studied in Korea by now. The objective of the present paper is to fill this gap and build a basis for the conservation and management of the breeding ground.

II. STUDY AREA AND METHODS

The breeding colony of the Black-crowned Night Herons under study is situated at Kumsan-ri, Tong-myon, Ch'angwon-gun in Kyungsangnam Prov. (128°40'E, 35°19'N) and covers an area of 0.81 ha (Fig. 1: A). It is situated on the southern slope (inclination of 20 degrees) of a 50 m-high hill. The Peakwol Mt. (400 m a.s.l.) is to the west of the breeding area and a part of the Junam Reservoir (365 ha in total area) to the east; to the south and north of the breeding area there are persimmon orchards. Besides the Black-crowned Night Herons, the Little Egrets and the Intermediate Egrets breed together in this colony, whereas the Eastern Great White Egrets, Grey Herons and Cattle Egrets breed in a mixed colony 450 m apart (Fig. 1: B). The investigated heronry (Phot. 1) is located in a mixed forest composed of pines *Pinus densiflora* in 75%; whereas its remaining 25% consists of deciduous trees: false acacia *Robinia pseudoacacia,* black alder *Alnus*

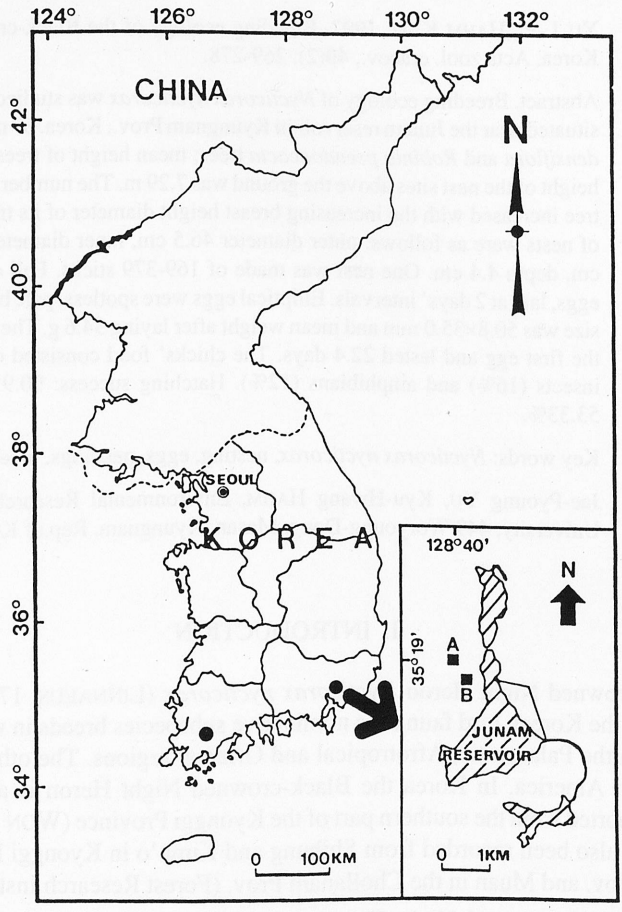

Fig. 1. Situation of two breeding places of the Night Herons in the Chollabuk and Kyongsangnam provinces of Korea (black dots). The location of heronries described in this paper is shown in enlargement in the inset: A – colony of *Nycticorax nycticorax, Egretta garzetta* and *E. intermedia;* B – colony of *Bubulcus ibis, Egretta alba modesta* and *Ardea cinerea.*

japonica, white oak *Quercus aliena* and lacquer *Rhus verniciflua.* In summer the Junam Reservoir plays a significant role as resting and foraging ground of Night Herons and Egrets; it is also a well known winter quarter of such winter visitors as the Baikal Teal and other ducks.

Detailed data concerning eggs, chicks and their development were taken from 8 nests visited every 3 days from 9th April to 2nd July 1993. Vernier caliper (Mitutoyo, 0.05 mm) and 2 m tape measure (1 mm) were used for measuring eggs and chicks; their weights were taken with a steelyard (0.5 g). The forest flora was investigated on 20 July i.e. after the nests had been left by young herons. The following measuremets were taken: tree heights, breast-height diameters of tree trunks (BHD) and heights of the nest sites above the ground. Four nests were collected and analysed in detail at the laboratory. The materials used for building each of the three nest layers (lower, middle and upper) were identified and counted; the lengths, diameters and weights of sticks and stems used as nest material were taken.

III. RESULTS

1. Nests

Of the 67 nests of the Night Herons breeding in the investigated colony as many as 64 were built in *Pinus* trees and the remaining three nests in *Robinia* – no nests were built in *Alnus, Quercus* and *Rhus* trees. The number of nests built in one pine tree varied from 1 to 13 ($\bar{x}$ = 2.90 ± 2.67). There were no more than one nest built in a single acacia tree. The height of 25 trees used by birds for nesting ranged between 5.6 and 10.0 m ($\bar{x}$ = 7.81 m ± 1.16) and their BHD was 7.9-31.2 cm ($\bar{x}$ = 14.8 cm ± 5.45). The nests were situated at a height between 4.3-8.9 m above the ground ($\bar{x}$ = 7.29 m ± 0.92).

The height of nest sites is significantly correlated with the height of trees (Fig. 2).

Fig. 3 shows that the BHD is positively correlated with the height of trees ($r = 0.61$, $p < 0.01$) and with the number of nests ($r = 0.71$, $p < 0.01$).

The nests were elliptical, shallow and dish-shaped (Phot. 2). A schematic section of a nest, showing its layers, proportions and the manner of measuring, is given in Fig. 4. The nests were built of various sticks, stalks and stems and lined with more delicate material. Most of twigs were straight and branched. The data concerning the species composition and number of sticks used for

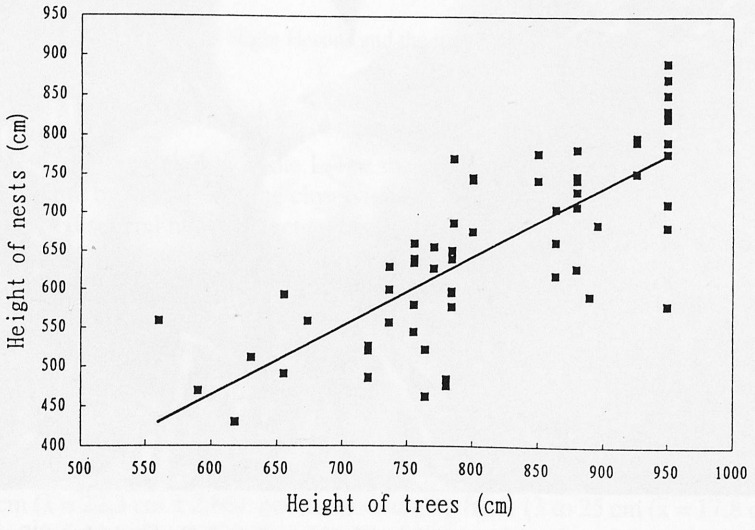

Fig. 2. Correlation between the height of trees and the height of Night Herons' nest sites ($r = 0.604$, $p<0.01$, $n = 67$).

Phot. 1. General view of the heronry investigated (Fig. 1: A) in the Kyongsangnam province.

Phot. 2. Nest of *Nycticorax nycticorax* containing 4 eggs and 1 newly hatched nestling in the heronry investigated.

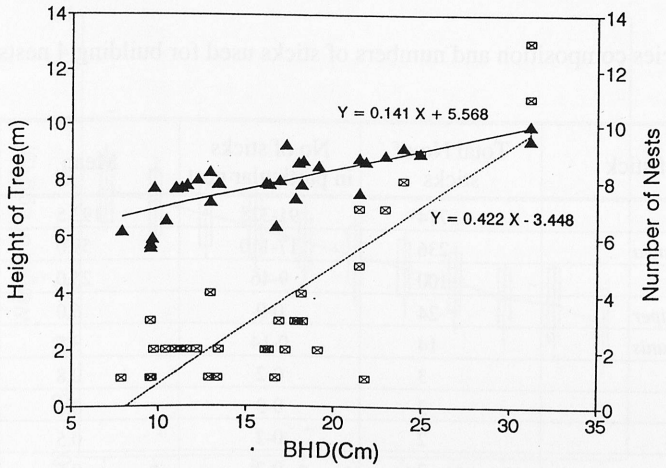

Fig. 3. Correlation between the breast-height diameters of trees (BHD) and the height of trees – black triangles and the solid line ($r = 0.609$, $p<0.01$) and between the BHD and the number of nests built in particular trees – crossed rectangles and dotted line ($r = 0.706$, $p<0.01$).

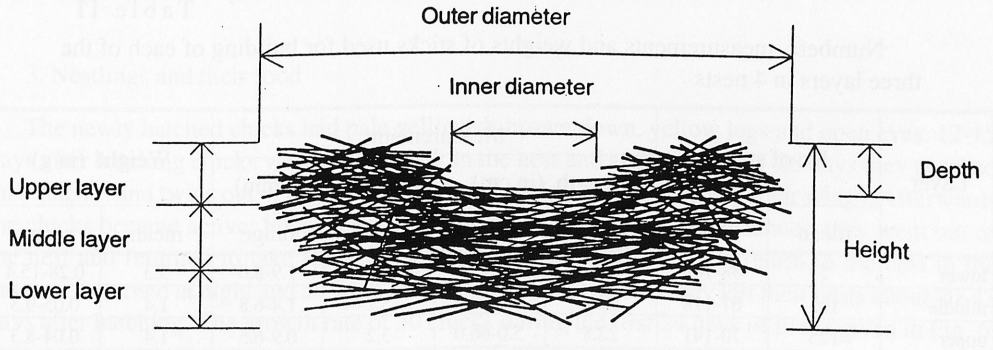

Fig. 4. Layers distinguished in nests of Night Herons and the manner of measuring the nests.

building four nests are presented in Table I. The most numerous of all were pine sticks (twigs) which could be found by the birds in the close vicinity of the nest; on the other hand, reed stems had to be transported several hundred meters from the reservoir. The numbers of sticks used for building each layer of the nests, their measurements (lengths and diameters) and weights are given in Table II. Generally, the lower layer was built of stronger and heavier material. Inside the nests, in the delicate material with which they were lined, there were some pine needles; it is however not clear if they had been placed there by the birds or whether they had dropped from the pine trees. No moss or grass was used for the nest lining.

The measurements taken from four nests collected were as follows:

the outer diameter 40-54 cm ($\bar{x} = 46.7$ cm $\pm$ 5.17); the inner diameter (the diameter of the nest cup) – 20-27 cm ($\bar{x} = 22.3$ cm $\pm$ 2.86); nest height ranging from 13 to 25 cm ($\bar{x} = 17.8$ cm $\pm$ 4.44) and nest depth: 2.0-6.4 cm ($\bar{x} = 4.4$ cm $\pm$ 1.60). The height and depth were more variable than the diameters.

Table I

Species composition and numbers of sticks used for building 4 nests studied in detail

Species of stick	Total No of sticks	No of sticks in particular nest	Mean	%
Pinus densiflora	774	91-328	193.5	64.34
Robinia pseudoacacia	236	17-110	59.0	19.62
Diospyros kaki	100	9-46	25.0	8.31
Persicaria hydropiper	24	0-9	6.0	2.00
Phragmites communis	14	0-14	3.5	1.16
Smilax china	3	0-2	0.8	0.25
Alnus japonica	3	0-3	0.8	0.25
Rosa multiflora	2	0-2	0.5	0.17
Quercus aliena	2	0-2	0.5	0.17
unidentified	45	1-33	11.3	3.74
	1203	169-379	300.9	100.01

Table II

Numbers, measurements and weights of sticks used for building of each of the three layers in 4 nests

Layer	No of sticks		Measurements				Weight (in g)	
			length (in cm)		diameter (in mm)			
	mean	range	mean	range	mean	range	mean	range
lower	73	38-108	32.2	11.0-73.5	4.2	1.9-8.0	3.3	0.28-15.4
middle	103	61-118	22.4	5.6-58.5	3.2	1.4-6.8	1.4	0.05-9.3
upper	125	70-141	22.8	5.0-66.0	3.2	0.9-6.5	1.4	0.04-8.3

2. Eggs, egg laying, incubation and hatching

Mating takes place during egg laying period – i.e. when pairing and nest building have been completed.

Eggs were laid at 2 days' intervals – there laying took 9 days in the case of 5 eggs. Full clutches consisted of 3-5 eggs. Mean clutch from 8 nests studied in detail was 4.1. Eggs were pale bluish-green, spottless, elliptical and it was difficult to distinguish them from the eggs of the Little Egret and Intermediate Egret. The dimensions of 33 eggs were as follows. Mean length – 50.8 mm ± 0.86 (range 49.7-52.4 mm), mean diameter – 35.0 mm ± 0.78 (range 34.0-36.0 mm). Mean weight just after laying – 34.6 g ± 1.16, (range 33.0-36.2 g). It decreased gradually (Fig. 5) and just before hatching was 29.9 g ± 1.1, (range 28.0-31.0 g) ($F_{(33, 330)} = 6.047$, $p<0.0001$, ANOVA).

The incubation period of each egg of a clutch lasted 21-24 days ($\bar{x} = 22.4$ days). It started right after the first egg was laid. The eggs hatched at a day interval and so the whole incubation period of the clutch lasted up to 29 days.

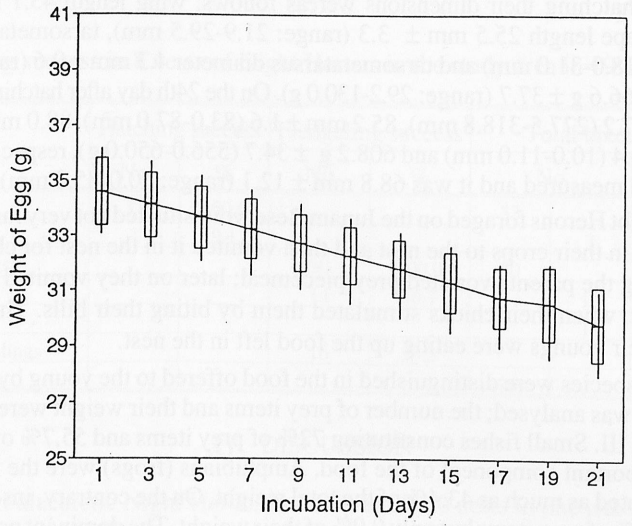

Fig. 5. Decreese in the weight of the Night Heron's eggs during the process of incubation; the diagram shows the ranges of weights of 33 eggs, their arithmetic means and the ranges of standard deviations calculated for every day of investigation.

3. Nestlings and their food

The newly hatched chicks had pale yellowish-brown down, yellow legs and open eyes. 12-15 days after hatching chicks were able to walk in the nest and at the age of 25-28 days they perched on branches and twigs out of the nest and at the same time started flapping their wings. Afterwards the chicks became active; hopping on branches and flying over short distances, they went out of the nest and returned to take food. Some of the chicks, which did not return to the nest in the daytime, returned at night and all were observed present at dawn. They left their nests about 40-43 days after hatching. The growth rate of 30 chicks during the first 24 days of life is given in Fig. 6.

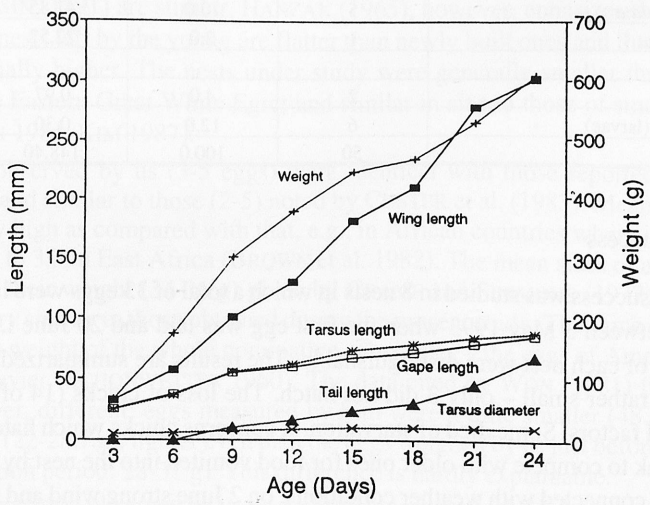

Fig. 6. Growth curves of the Night Herons' nestlings.

Three days after hatching their dimensions wereas follows: wing length 43.1 mm ± 7.2 (range: 34.7-47.3 mm), gape length 25.5 mm ± 3.3 (range: 21.9-29.5 mm), tarsometatarsus length 24.5 mm ± 5.2 (range: 18.0-31.0 mm) and tarsometatarsus diameter 4.3 mm ± 0.6 (range: 3.7-5.3 mm); mean weight was 66.6 g ± 37.7 (range: 29.2-130.0 g). On the 24th day after hatching those parameters were 300.6 mm ± 17.2 (277.5-318.8 mm), 85.2 mm ± 1.6 (83.0-87.0 mm), 88.0 mm ± 2.5 (85.0-90.0 mm), 10.2 mm ± 0.4 (10.0-11.0 mm) and 608.2 g ± 34.7 (556.0-650.0 g), respectively. In addition, the tail length was measured and it was 68.8 mm ± 12.1 (range: 50.0-85.0 mm).

The parent Night Herons foraged on the Junam Reservoir, situated not very far from the heronry. They carried prey in their crops to the nest and then vomited it in the nest for chicks. Up to 10-12 days after hatching the parents vomited prey piecemeal; later on they vomited the whole of food carried to the nest, when their chicks stimulated them by biting their bills. Then the adults flew away, whereas their youngs were eating up the food left in the nest.

Seven animal species were distinguished in the food offered to the young by their parents. The food composition was analysed; the number of prey items and their weight were taken. The results are given in Table III. Small fishes constituting 72% of prey items and 55.7% of their total weight were the most important component of the food. Amphibians (frogs) were the fewest in numbers (12%) but constituted as much as 43.4% of the total weight. On the contrary, insects (imagines and larvae) formed 16% of prey items but only 0.9% of their weight. The dominant prey was fish (loach) *Misgurnus mizolepis* whose length varied from 5 to 8 cm and was weakly correlated with the age of nestlings. The offering of insects was not related with the age of nestlings.

Table III

Composition of 50 prey items (numbers and weight) offered by adult Night Herons to their nestlings

Species	Individuals		Weight	
	Numbers	%	g	%
Pisces:				
Misgurnus miuzolepis	26	52.0	55.66	37.5
Carassius auratus	5	10.0	19.48	13.1
Acanthorhodeus asmussi	5	10.0	7.62	5.1
Amphibia:				
Rana nigromaculata	5	10.0	41.85	28.2
Rana catesbeiana	1	2.0	22.52	15.2
Insecta:				
Sympetrum sp.	2	4.0	0.97	0.7
Scapsipedus sp. (larvae)	6	12.0	0.30	0.2
Total	50	100.0	148.40	100.0

4. Breeding success

The breeding success was studied in 8 nests in which a total of 33 eggs were laid. Observations lasted 49 days between 3 May 1993 when the first egg was laid and 20 June i.e. the last day on which fledglings of each nest were distinguishable. The results are summarized in Table IV. The loss in eggs was rather small – only 3 did not hatch. The loss of chicks (14 of 30 hatched) was caused by several factors. Some died of starvation. It concerns chicks which hatched last in a nest and were too weak to compete with older ones for food vomited into the nest by parent birds. The other losses were connected with weather conditions: on 2 June strong wind and rain (10m/sec, 80 mm – Central Meteorological Service 1993) damaged some nests and the youngs fell out.

Table IV

Breeding success in 8 nests of Night Herons in the study area in 1993

	Hatching success		Fledgeling success		Total breeding success			
	No	%	No	%	No		%	
No of eggs laid	33	100.0			33		100.0	
Losses of eggs	3	9.1				3		9.1
No of hatched nestlings			30	100.0	30		90.9	
Mortality of young			14	46.7		14		42.4
Total of losses						17		51.5
No of surviving fledgelings			16	53.3				
Total breeding success					16		48.5	

IV. DISCUSSION

In the Western Palaearctic Night Herons build up to 20-30 nests in one tree at heights of 2-50 m (CRAMP and SIMMONS 1977; PERRINS et al. 1990). According to HANZAK (1965), who studied 662 nests in the Czech Republic, the nesting height depends on the plants in which they are built: nests built in common reeds and reed maces were situated 0.5-2.0 m above water level, those in willows – 1.5-4 m, in birch, alder and pine trees – up to 12 m, whereas in oaks even 25 m above the ground. SPANGENBERG (1950) writes that nesting height depends on the tree height as well as on the species composition of the heronry; for example, in mixed colonies of Night and Grey Herons the highest sites may be occupied by the latter species. WON (1981) observed 1-4 nests in a tree at a hight of 1.3-3.6 m. The present data differ from those reported by WON (1981), as the nests were built considerably higher. On the other hand, they confirm HANZAK's (1965) observations concerning pine trees. WON (1992) listed the species of plants in which the nests were built; they were *Celtis chinensis, Prunus padus* and *Pseudosasa japonica*, this last being a kind of bamboo. So, the possibilities of the Night Heron in Korea as to its nest site are much more differentiated than in the colony under study.

Nests measured by HANZAK (1965) had both diameters smaller than those presented in this paper, but the upper limits of the height and depth of their nest cups were distinctly higher. The data cited by VOISIN (1991) are similar. HANZAK (1965), however, ephasizes that at the end of a breeding season, nests left by the young are flatter than newly built ones and that last year's nests renovated are usually higher. The nests under study were generally smaller than those of large egrets such as the Eastern Great White Egret and similar in size to those of small egrets like the Little Egret (WON 1981; KIM 1987).

Clutch sizes observed by us (3-5 eggs) were identical with those reported by CRAMP and SIMMONS (1977) and similar to those (2-5) noted by CUSTER et al. (1983). Mean clutch size (4.1) was however very high as compared with that, e.g., in African countries where it varied from 2.2 eggs in Transvaal to 3.3 in East Africa (BROWN et al. 1982). The mean sizes of eggs (50×36 mm) and the ranges of their weight (34-36 g) given by CRAMP and SIMMONS (1977) for the Western Palaearctic are very similar to those obtained during the present study. The same can be said about the mean size and weight of the whole nominative subspecies – the eggs of American subspecies are larger and heavier (SCHONWETTER 1960). The data cited by WON (1981) from the south of Korea are, however, different: eggs measured by him were a little smaller (48.2×34.6 mm) and distinctly leighter (22-28.7 g), lighter even than the eggs weighed by us just before hatching (at the end of the incubation period: 28-31 g). This difference is hardly explainable.

The incubation period observed by us was a little longer than 21-22 days noted by CRAMP and SIMMONS (1977) from the Western Palaearctic and 21 days cited by AUSTIN and SINGER (1983)

from North America. In the Little Egret it is similar and lasts 23 days, whereas in the case of larger species of herons it is longer, lasting 25-28 days in the Grey Heron and 26-28 days in the Eastern Great White Egret (WON 1981; KIM 1987).

The interval between the hatching of chicks and their leaving the nests observed by us (41-43 days) is a little shorter than 40-50 days reported from the Western Palaearctic (CRAMP and SIMMONS 1977) and Africa (BROWN et al. 1982). According to AUSTIN and SINGER (1983) in America the young leave the nest a month after hatching but do not fly well until they are about 6 weeks old. These data correspond generally with our results. And so, the 28th day cited by WON (1981) concerns the young perching outside the nest but not their leaving the nest and flocking. In larger heron species breeding in Korea the period between hatching and leaving the nests is longer, just as is the time of incubation, i.e. in the Eastern Great White Egret it lasts 50-56 days (KIM 1987) and in the Grey Heron - 50-55 days (WON 1981).

Feeding grounds of the Night Herons from the heronry studied were rather close to it. However, according to CRAMP and SIMMONS (1977) feeding flights of these birds may be as long as 10-20 km. Other species of small herons (e.g. Little Egret) can also fly a dozen kilometers or so (HANEDA & IWASAKI 1982). As to the food composition, the results obtained in Japan by AKIMITSU (1960) show similar proportions of prey items of fishes, insects and amphibians to those observed by us.

The area investigated is very important from the point of view of nature protection. Six heron species breed in the same territory in two heronries, lying several hundred meters apart and close to the Junam Reservoir, which is a rich source of food. So, the protection of this area is an urgent matter.

REFERENCES

AKIMITSU K. 1960. On the food habits of some herons. Yamashina Inst. Ornith., **2**(2): 23-98.

AUSTIN O. L. Jr., SINGER A. 1983. Birds of the World. Golden Press, New York.

BROWN L. H., URBAN E. K., NEWMAN K. 1982. The Birds of Africa. Academic Press, **1**.

CENTRAL METEOROLOGICAL SERVICE. 1993. Daily Meteorological Data (Masan).

CRAMP S., SIMMONS K. E. L. 1977. The Birds of the Western Palearctic. Oxford Univ. Press, **1**.

CUSTER T. W., HENSLER G. L., KAISER T. E. 1983. Clutch size, reproductive success and organochlorine contaminants in Atlantic Coast Black-crowned Night-herons. Auk, **100**: 699-710.

HAHM K. H. 1984. Bird census of Junam, Yongweon and Noksan areas in the Kyungsangnam province. Theses Collection, Kyungnam Univ., **11**: 459-497.

HAHM K. H., KIM C. S. 1993. A study of the distribution of birds in the Sonaktonggang. Inst. Environm. Res., Kyungnam Univ., **15**; 69-80.

HANEDA K., IWASAKI A. 1982. Population fluctuation and spatial distribution of Little Egrets *Egretta garzetta* in the Zenkoji Plain. Tori, **31**: 42-56.

HANZÁK J. 1965. Hnízdní biologie kvakoše nočního (*Nycticorax nycticorax*) na Jihočeských koloniích. Sylvia, **17**: 23-76.

KIM S. M. 1987. A breeding ecological study of the Eastern Great White Egret, *Egretta alba modesta* in Korea. A Master's Thesis, Kyungnam Univ., 52 pp.

PERRINS C. M., JACKSON J. A., FORD H. 1990. The Illustrated Encyclopedia of Birds. Headline Book Publishing PLC, London.

SCHONWETTER M. 1960. Handbuch der Oologie. Akademie Verlag, Berlin, Lief. 2.

SPANGENBERG E. P. 1950. Kvakva *Nycticorax nycticorax* L. [In:] G. P. DEMENTEV, N. A. GLADKOV (Eds.) 1950 – Ptitsy Sovetskogo Soyuza [The Birds of Soviet Union], Sov. Nauka, Moskva, **2**: 445-453.

VOISIN C. 1991. The Herons of Europe. T. & A. D. POYSER, London, 364 pp.

WON P. O. 1981. Illustrated Flora and Fauna of Korea, vol. **25:** Avifauna. Ministry of Education, Seoul.

WON P. O. 1992. Animal Treasures (Natural Monuments) in Korea. Daewonsa, Seoul.

WON P. O., HAHM K. H. 1984. A preliminary assessment of bird population and species diversity on the Nakdong River Estuary and Junam Reservoir in the south eastern part of Korean Peninsula. Theses Collection, Kyungnam Univ., **13**: 99-117.