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VARIABILITY OF EGG-SIZE OF SOME SPECIES OF THE FOREST BIRDS*

The character of variability of egg-length and egg-width of *Turdus philomelos* Br., *T. merula* L., *Sturnus vulgaris* L., *Fringilla coelebs* L., *Coccothraustes coccothraustes* (L.) and *Garrulus glandarius* (L.) was examined. The attention was given to the causes of irregular distribution of egg-length and to the lack of correlation between egg-length and egg-width.

The aim of this paper is to examine the variability of length and width of eggs of some species of the forest birds, to indicate the factors determining this variability and also to supply the biometrical materials – concerning the eggs – characterizing populations inhabiting east part of the Mazowiecka Plain.

The research on the variability of eggs has been carried by: Kendeigh (1941), F. W. Preston, (1953), F. W. Preston, E. J. Preston (1953), Gemperle, F. W. Preston (1955), Richdale (1955), Kendeigh, Kramer, Hamerstrom (1956) and Koskimies (1957).

In Poland, Busse (1962) has initiated investigations in this field with his study, in which he described variations of the shape, colour and size of the eggs of a population of Tree Sparrow [*Passer montanus* (L.)], inhabiting Kabackie Forests near Warsaw.

Continuing investigations in this direction, it seems advisable to lead a series of examinations over the variability of size, colour, and shape of the eggs of various species of birds on the whole territory of the country with the aim of determining this variability, finding its causes, defining the influ-

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ence of geographical and ecological factors on this variability and also determining eventually the boundaries between the groups that may be called geographical populations.

DESCRIPTION OF THE TERRAIN, METHODS, MATERIALS

The present work was written on the basis of materials (Tab. I) gathered on the territory of Forest District Lipka, Forest District Administration Drewnica, District Wołomin, in the years 1960—1963. Physiographically this territory belongs to Mazowiecko-Podlaski region and the forest covering it are typologically very differential.

The number of eggs and clutches examined in the particular years

Tab. I

Species	Years								Generally	
	1960		1961		1962		1963			
	eggs	clutches	eggs	clutches	eggs	clutches	eggs	clutches	eggs	clutches
Turdus philomelos Br.	53	12	114	27	138	36	62	16	367	91
Turdus merula L.	6	3	36	8	37	10	14	3	93	24
Sturnus vulgaris L.	—	—	33	7	22	5	—	—	55	12
Fringilla coelebs L.	11	6	30	6	31	7	13	3	85	22
Coccothraustes coccothraustes (L.)	12	3	19	5	3	1	—	—	34	9
Garrulus glandarius (L.)	—	—	14	3	25	4	8	2	47	9

Generally speaking, it is possible to distinguish the following habitats:

a. Oak forest — a high wood of oak trees with hornbeam shrubs, locally some of hazel, birch, pine and aspen trees. Herbs grow during whole vegetative season.

b. Oak and hornbeam forest — differs from the above by the presence of hornbeam both in the overstory and in the understory.

c. Hornbeam forest – a high wood of hornbeam trees with hornbeam understory and very compact hornbeam shrubs. Locally some of hazel shrubs. Herbs grow only in the spring.

d. Pine forest – this name includes both pine young forest with a very little quantity of hornbeam and oak trees, and also woods of pine trees with oak young forest, aspen and birch shrubs. Grass or heath litter.

The basis for this paper are the measurements of eggs found in the nests. The eggs were measured with the slide gauge, with an accuracy of 0.1 mm.

The term "brood" applies to the process starting with making the nest and ended with leading out the nestlings. The term "clutch" is applied to the eggs from one nest. These terms will be used in this paper consequently in the above given meanings.

It was hardly possible to identify the brood to which each clutch found in the nest belonged. For this reason, in the case of Song Thrush (*Turdus philomelos* Br.) and Blackbird, (*T. merula* L.), whose eggs from the first and second broods are considered separately, the clutch found before May 20 is assigned to the first (*I*) brood, and the clutch found after May 20 to the second one (*II*). Such a division was made on the basis of the following data: in Klembow, these two species begin their broods about April 15 – and in this time first full clutches can be found. Average length of the brood beginning from the moment the first egg has been laid, is 30 days, (laying of eggs 4–5 days, hatching 12–14 days, nestlings remain in the nest for 12–14 days) (Dement'ev et al. 1954, Sokołowski 1958) of which the eggs remain in nest for 16–19 days. Assuming that the spread of time when individual pairs lay their eggs is two weeks long, we can expect that after May 20, there should be no eggs from the first brood in the nests. In reality, during the period between May 17 and May 25, most of the nestlings leave their nests.

General biometrical characteristic of the examined species

Tab. II

Species	Length			Width		
	scope of variableness	$\bar{X}$	σ	scope of variableness	$\bar{X}$	σ
Turdus philomelos	22.5–30.6	27.00	1.253	16.6–22.0	20.40	0.8166
Turdus merula	26.2–33.2	28.84	1.590	19.7–23.7	21.53	0.9493
Sturnus vulgaris	27.7–34.2	29.70	1.483	19.7–22.2	21.20	0.6215
Fringilla coelebs	17.8–21.3	19.18	0.7436	13.2–15.8	14.64	0.4728
Coccothraustes coccothraustes	21.7–26.6	23.73	0.9587	16.2–18.3	17.44	0.5006
Garrulus glandarius	28.2–34.2	31.50	1.383	21.4–24.7	22.63	0.8265

General biometrical characteristic of the examined species is given in Table II.

RESULTS

Turdus philomelos Br. – Song Thrush.

From both the measurements that determine the egg-size, more variable is length – its coefficient of variation being 4.5, the difference between the largest and the smallest measurements is 30%, on the average. Also in individual clutches the length variation is higher than the width variation.

General distribution curve of the egg-length (Fig. 1) is irregular with slightly marked bipeakness. general distribution curve of the egg-width (Fig. 2)

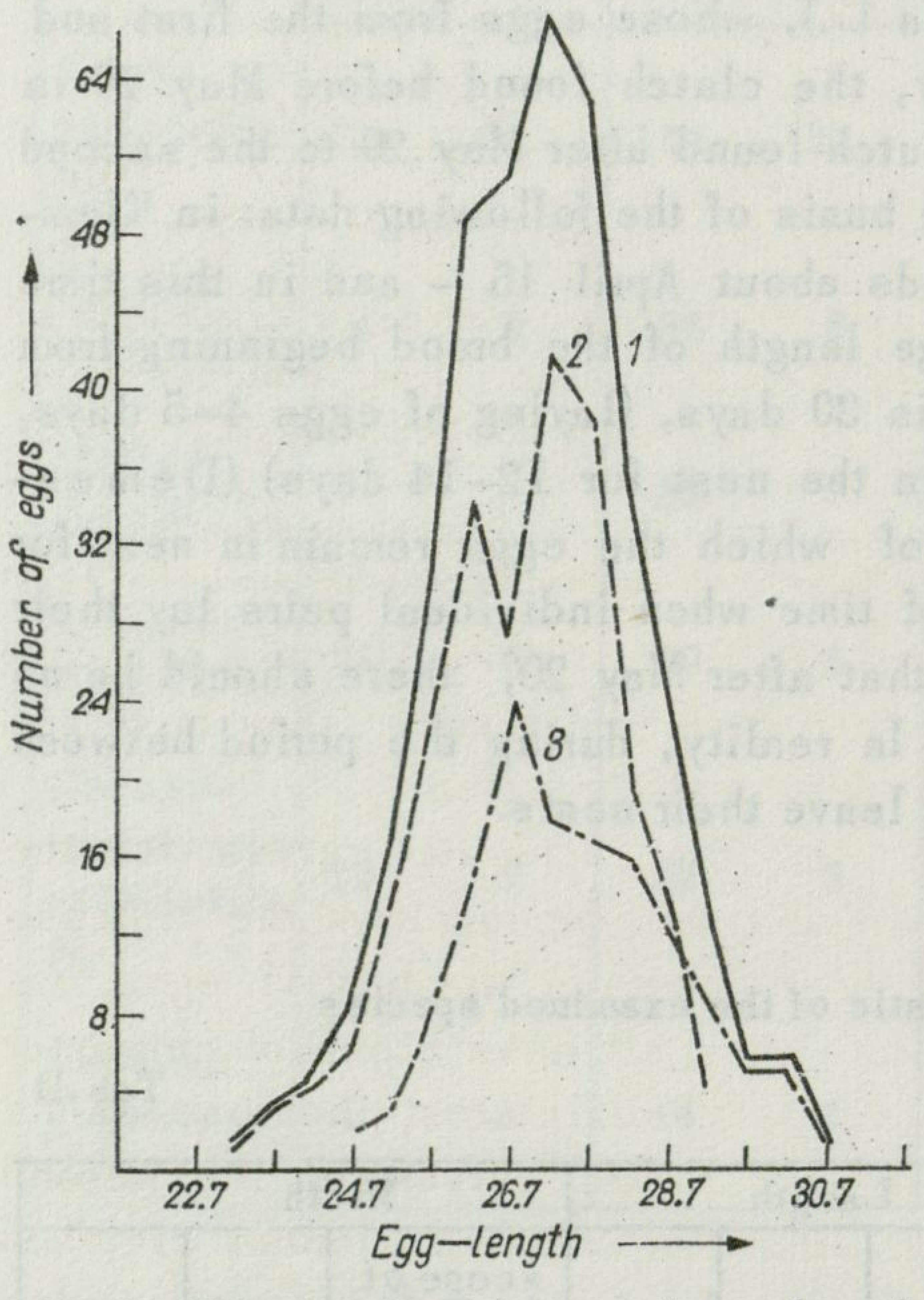

Fig. 1. Distribution curves of egg-length in Song Thrush (*Turdus philomelos*)
1 – general curve, *2* – brood *I*, *3* – brood *II*

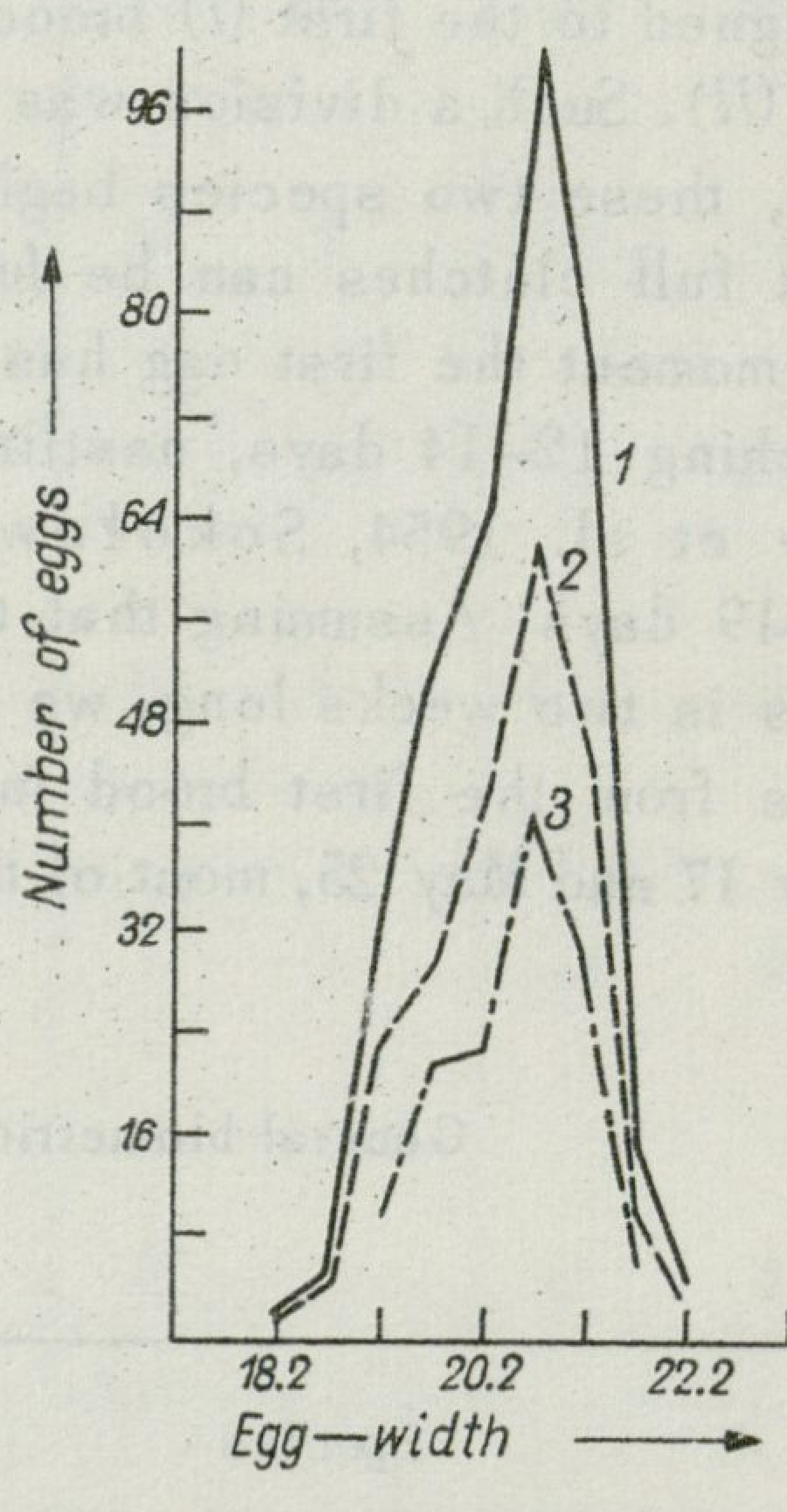

Fig. 2. Distribution curves of egg-width in Song Thrush
For explanations see Fig. 1

is regular. The eggs from the first brood are somewhat shorter ($\overline{x}$ = 26.88 mm) than those from the second brood ($\overline{x}$ = 27.29 mm) – the average difference is statisticaly significant. Average widths of the eggs from both the broods are identical. Neither width nor length are dependent upon the number of the eggs in the clutch. On the basis of the above data it can be presumed that the factors which affect the egg-size, have different effect on the length than that on the width of the eggs, or that each of these two measurements depends from the action of different factors. This presumption is confirmed by the fact that length variation is not correlated with the width variation (correlation coefficient is 0.27).

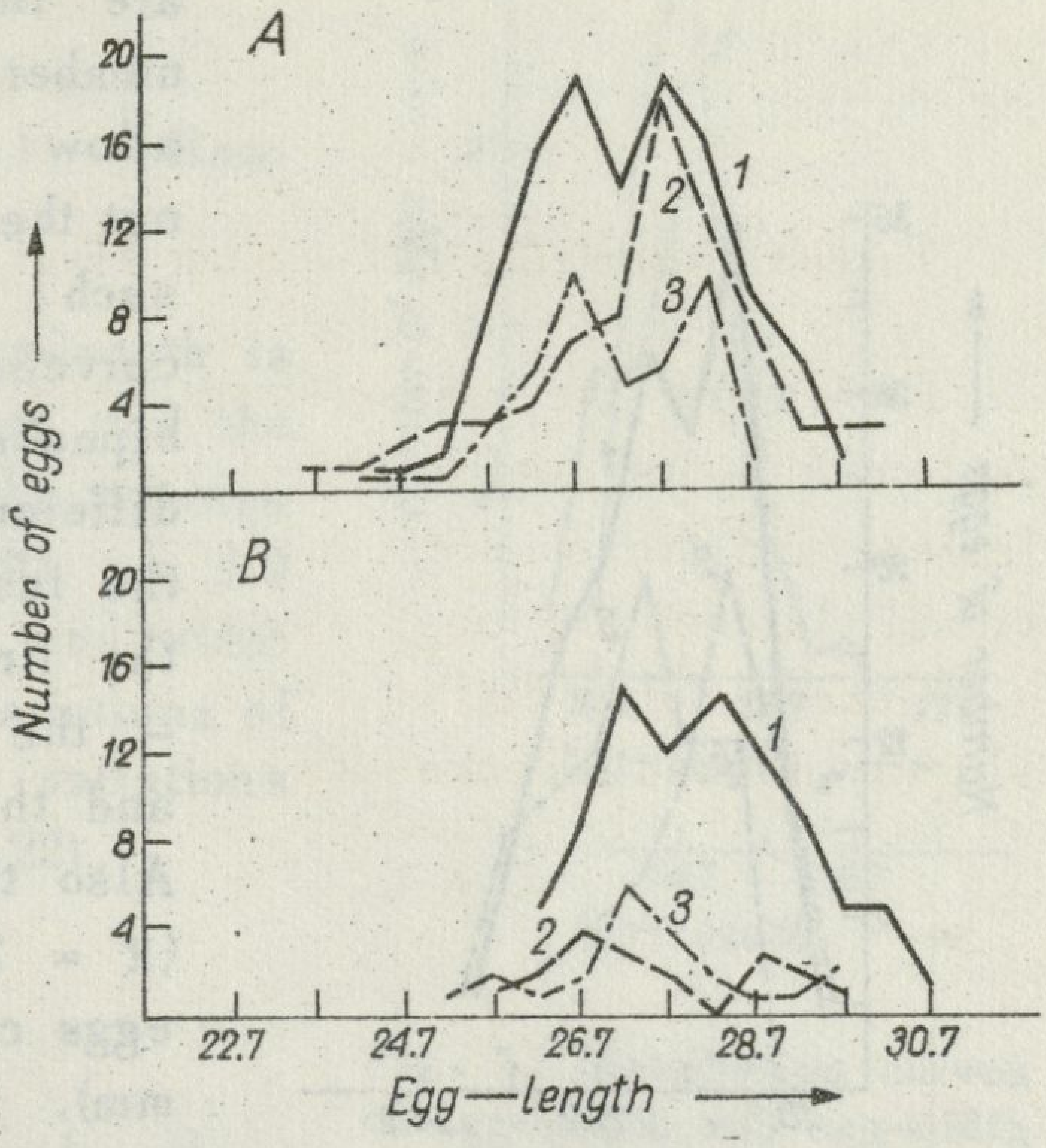

Fig. 3. Distribution curves of egg-length in Song Thrush, coming from clutches with different number of eggs

A – brood *I*, *B* – brood *II*; *1* – the clutch containing 5 eggs, *2* – the clutch containg 4 eggs, *3* – the clutch containing another number of eggs

Irregular distribution of length measurements appears more strongly when the curves for the first and second broods are drawn separately (Fig. 1). One can see that the curve of the first brood forms clearly two peaks, this bipeakness is statistically significant (P = 0.008; calculated according to the following formula $y_0 = \frac{n \cdot i}{6 \sqrt{2\pi}}$ [1]; Simpson and Roe 1939), while the curve of the second brood is regular, similar to the normal curve, and its deviations are statistically insignificant (P = 0.448). Bipeakness of the curve of the first brood appears in all the curves drawn separately for the eggs from several years of observations. Although the corresponding curves of the second brood show some irregularity, they have not clearly bipeakal character.

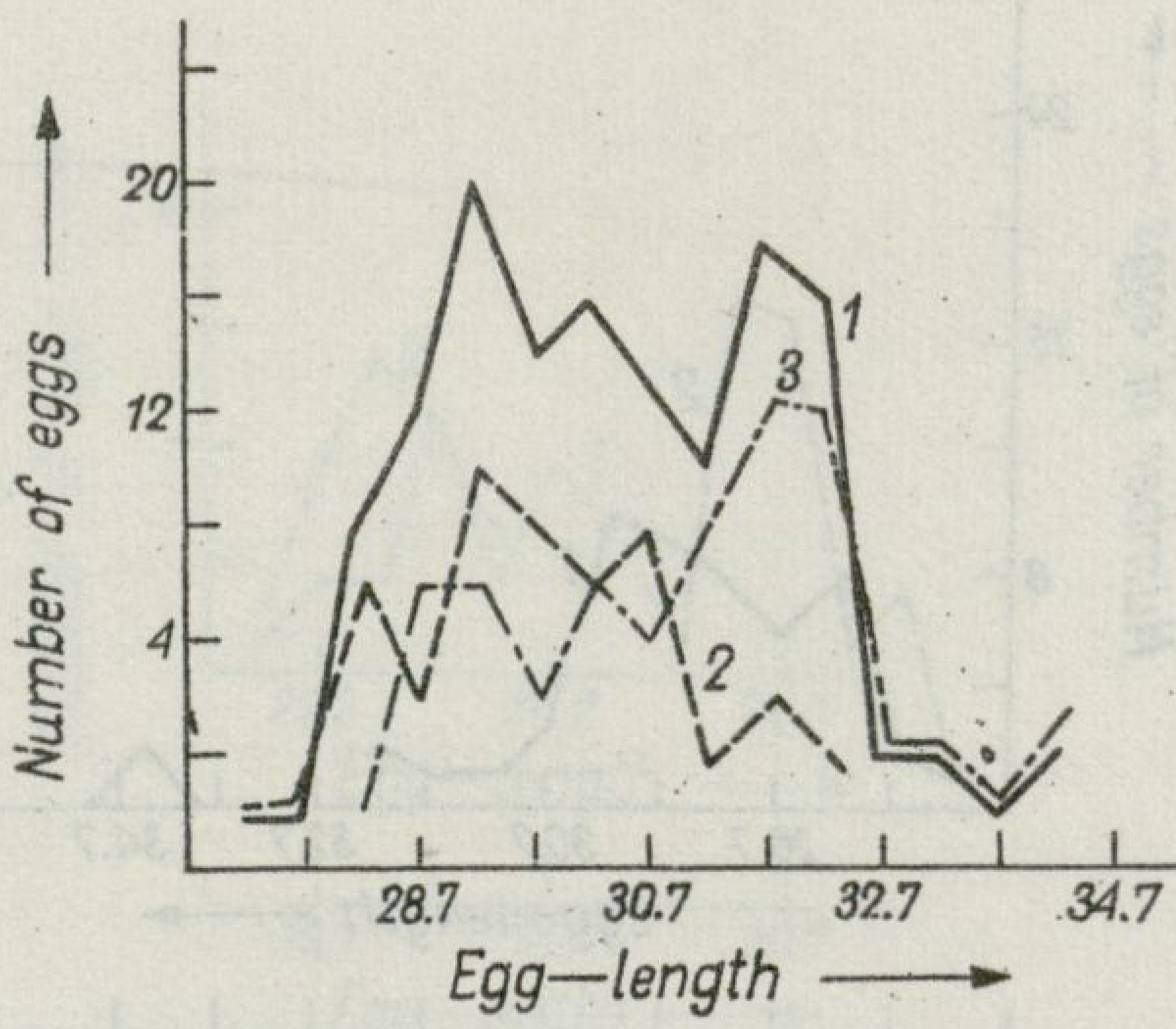

Fig. 4. Distribution curves of egg-length in Blackbird (*Turdus merula*)

For explanation see Fig. 1

If we draw separate curves for the first brood eggs, coming from the clutches which have various number of eggs, we see, that they all have bipeakal character (Fig. 3). It is of interest that one of the analogously drawn curves of the second brood, from the most numerous clutches for this brood, containing 5 eggs, is also clearly bipeakal, however this bipeakness dissapears in the general picture of the second brood.

Turdus merula L. – Blackbird.

Coefficient of variation for the egg-length is 5.3, the difference between the largest and the smallest measurements being 24.3% of the average value. Analogous numbers for the width are 4.4 and 18.5%.

[1] y_0 – value of maximum ordinate of the normal curve, n – quantity, i – class interval.

General distribution curve for length of the eggs (Fig. 4) is irregular, irregular are also the curves draw for the individual broods. All these curves are threepeakal – unfortunately too small number of the measurements taken does not allow to carry out the analysis and to find out the presumable causes which decide about such a distribution. General distribution curve of the egg-width (Fig. 5) is clearly bipeakal. This distribution is caused by the difference in size of the eggs coming from the individual broods (Fig. 5): the eggs from the first brood are narrower ($\bar{x}$ = 21.90 mm) – the difference is statistically significant and these measurements form the first peak. Also the length of eggs from the first brood ($\bar{x}$ = 28.79 mm) is smaller than that of the eggs coming from the second brood ($\bar{x}$ = 30.01 mm). The variations of the length are not correlated with the variations of the width (correlation coefficient is 0.34).

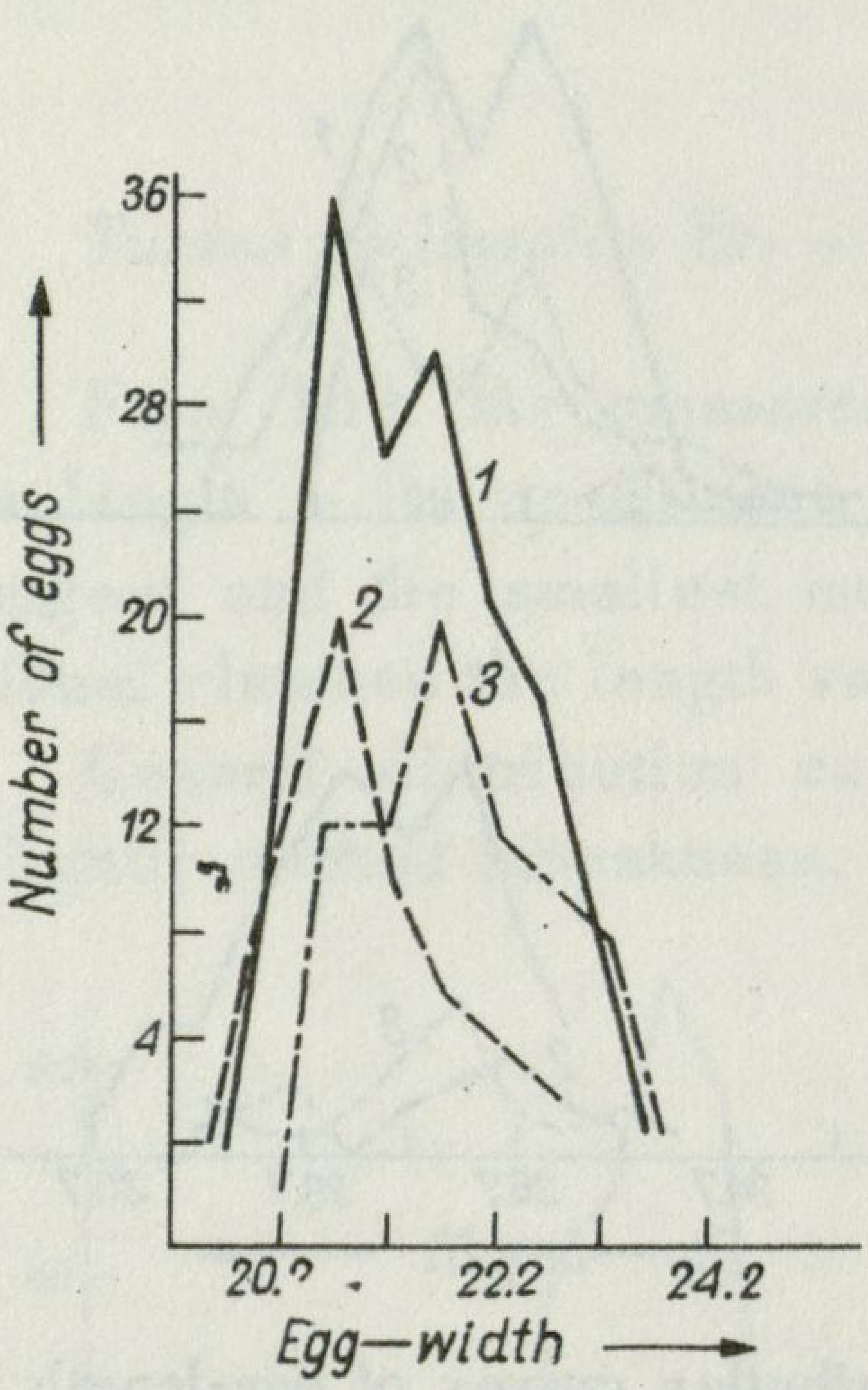

Fig. 5. Distribution curves of egg-width in Blackbird
For explanation see Fig. 1

Sturnus vulgaris L. – Starling

Coefficient of variation for the egg-length is 4.9, the difference between the largest and the smallest measurements is 15.1%, of the average value. Analogous numbers for the width are 2.9 and 11.7%. The distribution of length and width of the eggs is given in Figure 6. The variations of the length are not correlated with the variations of the width (correlation coefficient is 0.15).

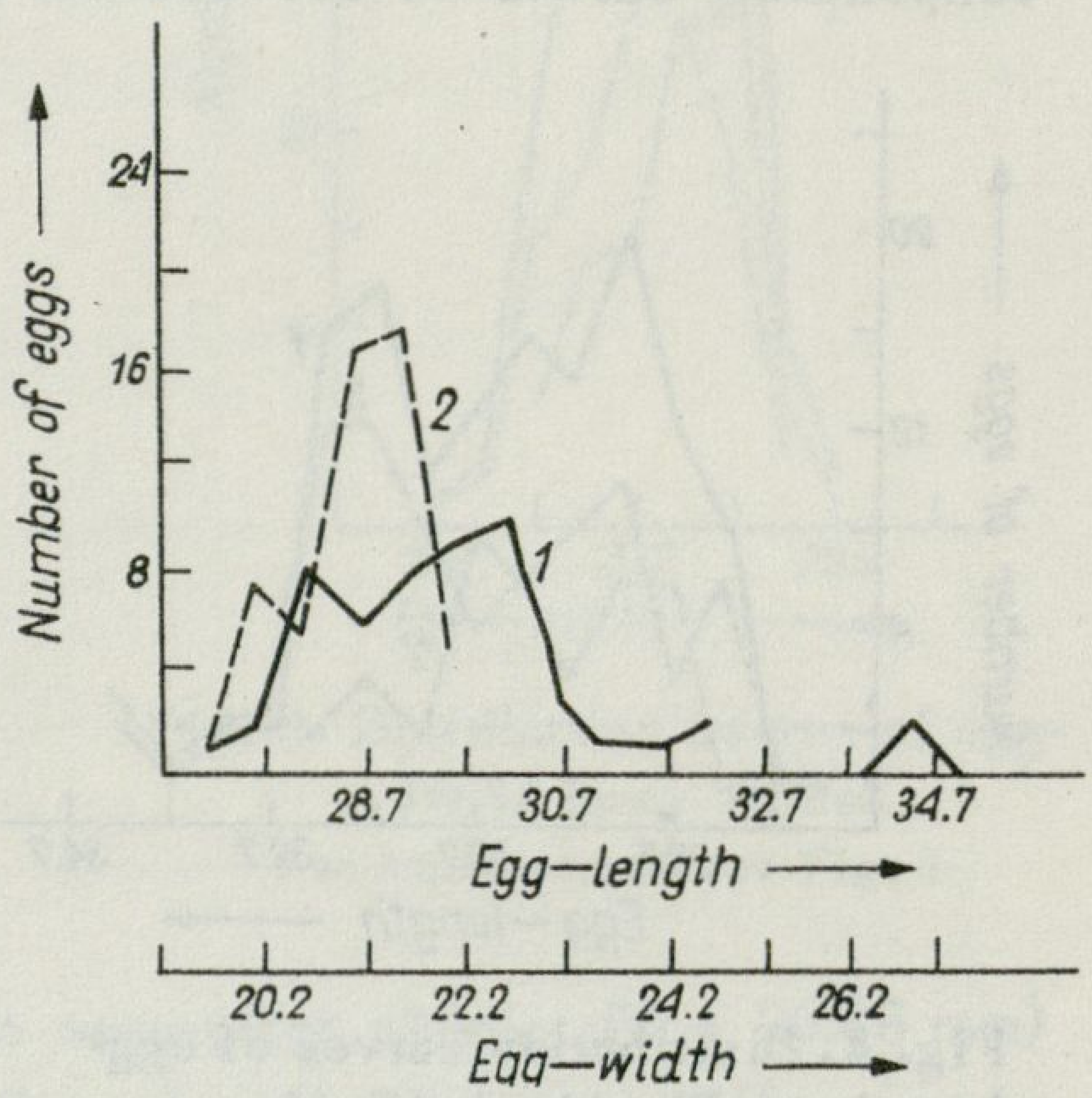

Fig. 6. Distribution curves of egg-length and egg-width in Starling (*Sturnus vulgaris*)
1 – length, 2 – width

Fringilla coelebs L. – Chaffinch.

Coefficient of variation for the egg--length is 3.9, the difference between the largest and the smallest measurements is 18.2% of the average value. Analogously for width 3.2 and 17.7%. The distribution of length and width of the eggs is given in Figure 7. The variations of the length are not correlated with the variations of the width (correlation coefficient is 0.05).

Coccothraustes coccothraustes (L.) – Hawfinch.

Coefficient of variation for the egg-length is 4.0, the difference between the largest and the smallest measurements is 20.6% of the average value. Analogous numbers for the width are 2.9 and 12.0%. The distribution of length and width of the eggs is given in Figure 8. The variations of the length are not corelated with the variations of the width (correlation coefficient is 0.22).

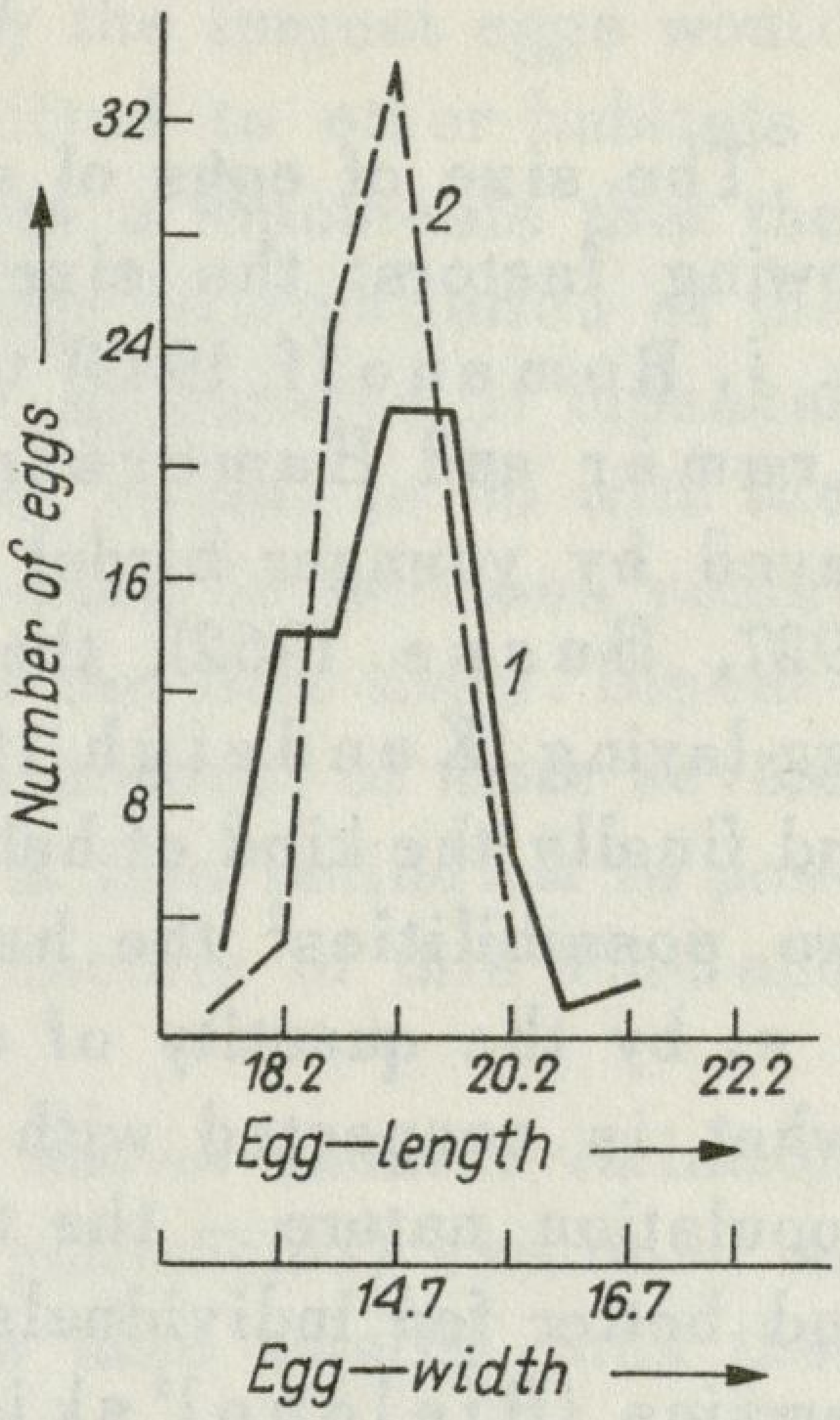

Fig. 7. Distribution curves of egg-length and egg-width of Chaffinch (*Fringilla coelebs*)
For explanation see Fig. 6

Garrulus glandarius (L.) – Jay.

Coefficient of variation for the egg-length is 4.8, the difference between the largest and the smallest measurements is 19.0% of the average value. Analogous numbers for the width are 3.7 and 14.1%. The distribution of length and width of the eggs is given in Figure 9. The variations of the length are not correlated with the variations of the width (correlation coefficient is 0.21).

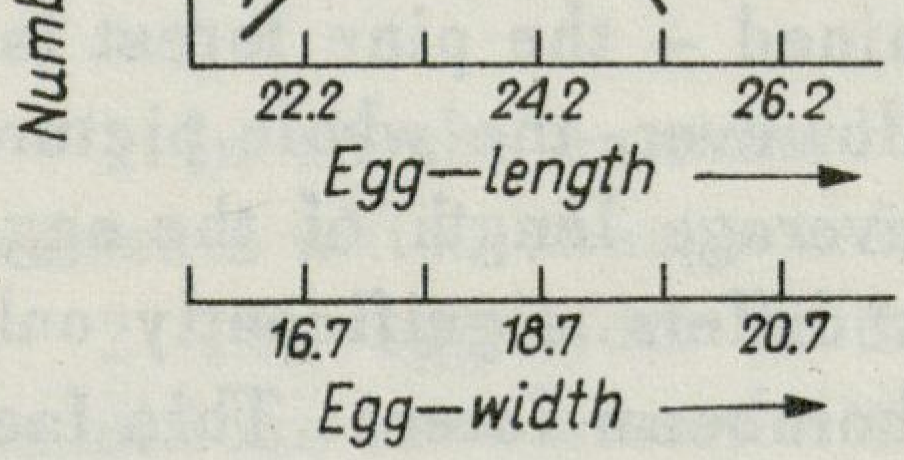

Fig. 8. Distribution curves of egg-length and egg-width in hawfinch (*Coccothraustes coccothraustes*)
For explanations see Fig. 6

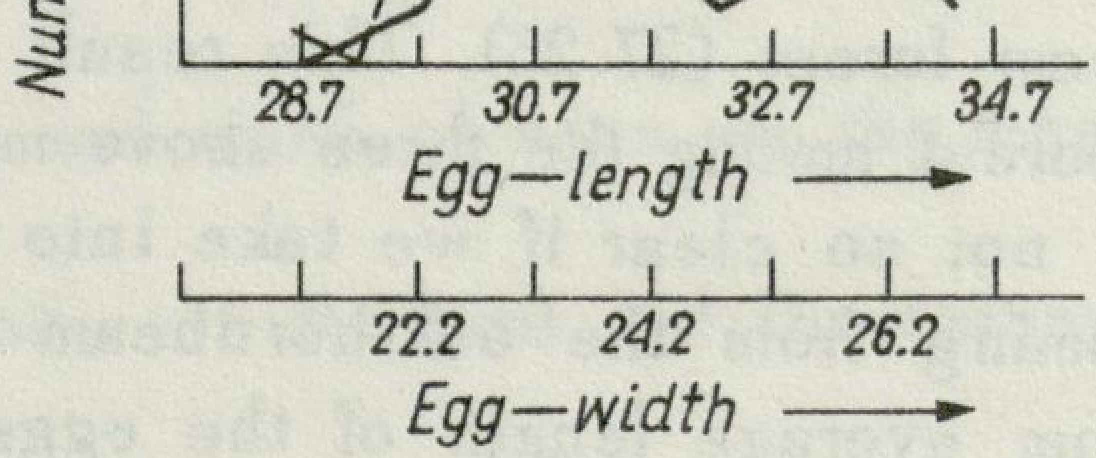

Fig. 9. Distribution curves of egg-length and egg-width in Jay (*Garrulus glandarius*)
For explanations see Fig. 6

DISCUSSION OF THE RESULTS

The size of eggs of some species of birds can be dependent upon the following factors: the size of the bird laying the egg (L. E. Romanoff and A. J. Romanoff 1949) the age of the bird (Groebbels 1937, Kendeigh, Kramer and Hamerstrom 1956 – according to them, the smaller eggs are layed by younger birds) the number of the eggs in the clutch (Groebbels 1937, Busse 1962), the atmospherical conditions prevailing at the time of egg-laying (Kendeigh 1941), the quantity of available food (Siivonen 1957) and finally the kind of habitat in which the bird nests. In the last case we have two possibilities: the habitat affects the birds inhabiting it by its fertility i. e. by the quantity of offered, easily accesible food, or on the other hand (what is connected with the previous matter) come into play the factors of population nature – the terrains more useful are occupied by stronger, bigger, and better fed individuals whereas weaker individuals are being push to worse terrains (Bielopol'skij 1957).

On the basis of presented above problems, several hipotheses explaining the causes of irregular distribution of egg-length in Song Thrush (T. *philomelos*) can be put forward. It seems that we absolutely must refuse the hipothesis which would assume that the bipeakness of the obtained curve results from the size differentiation of the population inhabiting the terrain examined into two distinct groups – the larger birds and the smaller birds. Although the variations in the egg-length are not correlated with the variations in width, it is hardly possible to expect the larger birds laying eggs longer only, without any changes in their width. Especially, if we consider, that this is the width which shows smaller variation within one clutch and seems to be strictly connected with the size of the bird.

Also ineffectual appears seeking the causes of bipeakness of the curve in the size differentiation of eggs of the birds nesting in different habitats – the curves drawn separately for the eggs coming from different habitats all show, to a lesser or greater degree, the bipeakal character. Average length of the eggs coming from pine forest (26.16) differs significantly from the average measurements of length of the eggs coming from oak forest (27.10) and hornbeam forest (27.25). This result can be easily explained – the pine forest is poorest among the three above mentioned habitats. However, the whole picture is not so clear if we take into consideration the average length of the eggs coming from the oak-hornbeam forest (26.39) – it differs significantly only from average length of the eggs coming from the hornbeam forest. This fact indicates to be more careful when drawing conclusions on the basis of the obtained average differences. Supposing that the eggs of the birds nesting in the poorer habitats were really smaller, then the eggs coming from the oak-hornbeam forest, being intermediate form between the oak and hornbeam forests should have been significantly different from the eggs coming from the pine forest. The received results could be comprehensible only in this case if we assumed that from some unknown causes the hornbeam forest is most willingly occupied by birds. The strongest individuals who lay the largest eggs would nest there and the, weaker individuals would be shifted to other habitats.

The materials presented above allow to put forward a hipothesis that the bipeakness of the curves of egg-length is caused by age differentiation of the population. Such an explanation can make the common appearance of bipeakal curves – undoubtedly in each of variants analysed above we had to do with the eggs coming from the old birds (which have been nesting in previous years) as well as from the young birds (which have nested for the first time). Bipeakness is more strongly expressed for the first brood on account of more severe climate and lesser quantity of easily available food at this period. It is possible that younger birds react in another way to the factors of this kind and also tolerate them worse than older birds.

Among all species discused above the egg-width shows smaller variation than the egg-length; in the case of Song Thrush (*T. philomelos*) examined on that account, variation of width within one clutch is also smaller than that of length. Distribution of width gives usually regular curve, aproximate to the normal curve: only in one case (Blackbird, *T. merula*) width have appeared clearly dependent upon the external conditions. Concerning the rest of species we can hazard the statement that the egg-width is dependent upon the size of a bird (inside diameter of oviduct) and that the external conditions have a very little influence upon it.

The distributions of egg-length are often irregular, the obtained curves bipeakal or threepeakal character. In the case of Song Thrush, bipeakal character of the curve can be explained by assuming the age differentiation of population and a different response of one-year-old birds than that of older birds to the external conditions. The facts presented above seem to suggest that the egg-length is more dependent upon the external conditions – this hipothesis is confirmed by clear dependence of the length of eggs upon the date of their laying (brood) in the case of Song Thrush and Blackbird.

CONCLUSIONS

1. In all the examined species, the length and width of eggs are the measurements which change independently.

2. The egg-width is dependent upon the size of the bird and the external conditions have a very little influence on it.

3. The egg-length is the measurement deeply dependent upon the external conditions.

4. A conclusion is drawn that in the case of Song Thrush (*T. philomelos*) the one-year-old birds lay smaller eggs (shorter) than the older birds which results in a bipeakal distribution curve of egg-length.

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ZMIENNOŚĆ WIELKOŚCI JAJ NIEKTÓRYCH GATUNKÓW PTAKÓW LEŚNYCH

Streszczenie

Celem pracy było zbadanie zmienności długości i szerokości jaj niektórych gatunków ptaków leśnych, wskazanie czynników determinujących tę zmienność oraz dostarczenie materiału biometrycznego dotyczącego jaj, charakteryzującego populacje zamieszkujące wschodnią część Niziny Mazowieckiej.

Napisana ona jest w oparciu o materiały (tab. I) zebrane na terenie leśnictwa Lipka, nadleśnictwo Drewnica, pow. Wołomin, w latach 1960–1963.

Obserwacje terenowe polegały na wyszukiwaniu gniazd i mierzeniu znajdujących się w nich jaj za pomocą suwmiarki z dokładnością do 0,1 mm. Podczas opracowywania, u gatunków, u których osobno rozpatrywane są jaja pierwszego i osobno drugiego lęgu, zniesienia znalezione do 20 V kwalifikowano jako zniesienie *I* lęgu, znalezione po 20 V – jako zniesienie *II* lęgu. Termin „lęg" oznacza proces zapoczątkowany budową gniazda, a zakończony wyprowadzeniem młodych. „Zniesienie" to jaja złożone do jednego gniazda. Ogólną charakterystykę biometryczną zawiera tabela II.

Na podstawie otrzymanych wyników stwierdzono, że:

1. U wszystkich badanych gatunków długość i szerokość są wielkościami zmieniającymi się niezależnie.

2. Szerokość jaja jest uzależniona od wielkości ptaka i warunki zewnętrzne odbijają się na niej stosunkowo słabo, wyjątek stanowi tu kos, *Turdus merula* L. (fig. 5).

3. Długość jaja jest wielkością silnie uzależnioną od warunków zewnętrznych.

4. Otrzymane u drozda śpiewaka, *Turdus philomelos* Br. dwuszczytowe krzywe rozkładu długości jaj (fig. 1 i 3) tłumaczy hipoteza, że ptaki jednoroczne niosą jaja mniejsze (krótsze) niż ptaki stare.

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