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Жерлянки Краковско-Хржановского Гребня и прилегающей части Долины Вислы

The Bombinators of the Kraków-Chrzanów Ridge and the adjacent part of the river Wisła valley

(Maps I—II and 1 text-figure)

THE PROBLEM

A chain of hills running westwards of Kraków and called the Kraków—Chrzanów Ridge (LENCEWICZ 1957) is one of the more interesting areas in Poland in the herpetological aspect, thanks to an „isle"-like distribution of mountain species of amphibians. Thus FUDAKOWSKI (1954) found the mountain newt (*Triturus alpestris* LAURENTUS) in Dulowa near Trzebinia, and SKALSKI (1953) found a spotted salamander (*Salamandra salamandra* (L.)) near Byczyna in the western prolongation of the Ridge towards Jaworzno. The finding in this area of the mountain bombinator (*Bombina variegata* (L.)) deserves especial attention; it has been quoted from the environs of Trzebinia by PONGRACZ (FEJÉRVÁRY 1923).

As the Kraków—Chrzanów Ridge belongs to the distribution area of the lowland bombinator (*Bombina bombina* (L.)) (Bayger 1937), the question arose whether the data on the appearance of the mountain bombinator in this territory are correct, and if it is so, what is its distribution and its influence on the population of the lowland bombinator. Moreover, as the southern part of the river Wisła valley belongs to the mixt zone (Michałowski 1958), it should be ascertained whether river Wisła forms an ecological barrier for the bombinators and whether their localities on both sides of the river will significantly differ from one another.

Investigations were performed in the years 1956—1958 on the territory of the Kraków—Chrzanów Ridge, the valley of river Wisła, the Krzeszowice trough fault and the southern border of the Kraków Jurassic landscape.

THE TERRITORY

The investigated territory lies in the Kraków district, in the counties Kraków and Chrzanów. Its total area amounts to about 520 squ. kilometres. The most important part, i. e. the Kraków—Chrzanów Ridge (Lencewicz, 1957; also called the Tenczyn elevation by Klimaszewski 1946), with a mean altitude of 350—400 metres above sea-level, forms the southern part of the Kraków Upland, in the north separated from the chief massif by the Krzeszowice trough fault (maps 1 and 2). In the south the Ridge borders with the valley of river Wisła, in the east it reaches the town Kraków (Mt. Sowiniec 358 metres, Mt. Sikornik 333 metres above sea-level). The latter hills are separated from the chief massif by the Cholerzyn depression (240 metres above sea-level). The highest elevations in the central and western part of the massif placed near the villages Rudno and Płaza exceed 400 metres above sea-level. The surface of the Ridge in its eastern part is chiefly covered by loess soils, in the western part there is a large proportion of rendzina soils besides loess (Tomaszewski, 1950). The rock substratum is made up of Triassic and Jurassic sediments.

The Krzeszowice trough fault (230—300 metres above sea-level) is a tertiary tectonical trough formed during the Carpathian orogeny. Its bottom is covered by loess soils and loamy sand soils (KLIMASZEWSKI, 1946; TOMASZEWSKI, 1950).

The valley of river Wisła lying in the south comprises two terrace levels; the lower one (about 240 metres above sea-level) is covered by heavier alluvial soils, and the higher one (about 280 metres above sea-level) — by loamy and sandy soils (LENCEWICZ, 1957; TOMASZEWSKI 1950).

The Krzeszowice trough fault and the northern part of the Ridge are reckoned by ROMER (1949) to the climate area of the central uplands, while the southern slopes of the Ridge and the river Wisła valley belongs already to the climate region of the foot-hills dales and valleys.

The chief water course is river Wisła, forming numerous meanders and old closed meanders; the river net is supplemented by its affluents — small rivulets as the Chechło, Rudawa, and Sanka. There are ponds everywhere; however, they do not form larger groups. Moreover, smaller ponds or larger puddles are frequent, although they are nearly completely absent in more rationally managed localities.

The investigated area is comparatively well afforested, especially in the higher parts of the Kraków—Chrzanów Ridge. There is a large forest complex, the Dulowa Great-Forest, lying south-east of Trzebinia. In the lower parts of the Wisła valley only fragments of forests were conserved.

THE MATERIAL AND METHODS

The survey was made in the years 1956, 1957, and 1958, from the end of April to the first half of August. The methods of searching, of catching, and conservation of the material were identical with those used in the area between rivers Wisła, Skawa, and Raba (MICHAŁOWSKI, 1958). The search was intended to be very through in all localities of the area. If no bombinators were found, the investigation was repeated, sometimes

even three times, in other seasons of the year or in other years. This was based on a series of observations from which it resulted that the bombinators of both species, or even of one of the species but living in different reservoirs, may show a different activeness in different times of the year or of the day. An interesting living-place was found in Młoszowa near Trzebinia, where the bombinators croaked on the shore hidden in rotted tree-trunks or under stones. They were probably frightened out of the pond by feeding ducks.

The classification of the material does not differ from that used previously (MICHAŁOWSKI, 1958). Thus six pairs of features were chosen (table I) for a nearer determination of both species of bombinators. According to their importance, marks — from 1 to 3 — were allotted to each feature. The maximum of marks obtained by a skin amounts to 12, the minimum — to 6. The classified skins were divided into four classes:

class I, 12—11 marks, typical form;

class II, 10—9 marks, non-typical form with some features belonging to the other species;

class III, 8—7 marks, non-typical form with many features belonging to the other species;

class IV, 6 marks, intermediate form with features equivalentely belonging to both species.

The average calculated from the total marks, as obtained from all the skins of bombinators caught, was used to characterise a given locality. This means for instance that a locality of the mountain bombinator of class I may comprise — besides dominating numbers of class I bombinators — also a few of these belonging to other classes of this species.

Some water reservoirs were considered as two or even three localities, if intermediate forms (class IV) or those belonging to the other species were found.

RESULTS

The data obtained from an investigation of the collected material are presented in two lists, two maps, and table II.

Table I

The characteristic and classification of the skin colouring and the disposition of skin warts in *Bombina bombina* (L.) and *B. variegata* (L.)

Species	*Bombina variegata* (L.)	*Bombina bombina* (L.)	Conventional value of feature
Feature of the Ist order	Dorsal warts surrounded by a larger number of concentrically disposed wartlets	Single dorsal warts	3 marks
	Yellow areas occupy more than half of ventral part of the body	Orange-coloured areas occupy less than half of ventral part of the body	
of the IInd order	On the breast there are two yellow areas uniting arc-wise with the yellow blots on ventral part of the arm	On the breast there are two isolated orange-coloured areas	2 marks
	Yellow areas on abdomen unite with yellow areas on ventral part of femur	Orange-coloured areas on abdomen do not unite with orange areas on ventral part of femur. On the limit between abdomen and femurs there are two transverse isolated orange blots, continuous or divided into several smaller ones	
of the IIIrd order	On the back between the shoulder-blades there are no distinct arched blots	On the back between the shoulder-blades there are two black, arc-like blots	1 mark
	On the body sides there are no white spots or only a few of them	On the black-blue under-ground of the body underside there are white dots, especially on the body sides	

List I

Localities of the bombinators

Locality	approx. altitude	Kind and location of reservoir	total specim.	(Average) Evaluation of material
Aleksandrowice	275 m	pond	9	7 B. bomb. cl. II, 2 intermed.
Bielany	220 m	ditch and swamp on meadow	7	7 B. bomb. cl. I
Brodła	275 m	puddles and small ponds	5	3 B. varieg.cl. II, 2 B. bomb. cl. III
Bronowice	220 m	ponds near river Rudawa	3	2 B. bomb. cl. III, 1 intermed.
Burów	300 m	small ponds in village	5	5 B. bomb. cl. II
Chełm	230 m	pond	10	9 B. bomb. cl. II, 1 intermed.
Cholerzyn	220 m	small pond on pasture	6	6 B. bomb. cl. II
Cichy Kącik	220 m	puddle	6	6 B. bomb. cl. II
Czernichów	225 m	pond near higway	11	8 B. bomb. cl. II, 3 intermed.
Grojec	370 m	small ponds in village	4	4 B. bomb. cl. II
Jankowice	230 m	small ponds near river Wisła	8	8 B. bomb. cl. I
Jeziorzany	225 m	small ponds near village	9	8 B. bomb. cl. I, 1 intermed.
Kamień	260 m	puddles near houses and small pond on meadow	7	5 B. bomb. cl. II, 1 B. varieg. cl. III, 1 intermed.
Kaszów	230 m	pond in village	4	4 B. bomb. cl. II
Kleszczów	340 m	loamy ponds	6	6 B. bomb. cl. II
Kłokoczyn	225 m	ditch on meadow	1	1 B. bomb. cl. I
Kryspinów	220 m	small ponds near village	7	7 B. bomb. cl. II
Luszowice	305 m	small ponds near railway line	8	8 B. bomb. cl. I
Mirów	260 m	puddle	10	5 B. varieg. cl. II, 5 B. bomb. cl. II
Młoszowa	310 m	pond near manor (caught on shore)	9	9 B. bomb. cl. II
Młyńska Góra	230 m	small pond near dam of water-supply	5	5 B. bomb. cl. II

Locality	approx. altitude	Kind and location of reservoir	total specim.	(Avarage) Evaluation of material
Mników	260 m	pond in ravine	7	6 B. bomb. cl. II, 1 B. varieg. cl. III
Nieporaz	300 m	small pond on meadow near village	1	1 B. bomb. cl. I
Okleśna	230 m	puddles on pasture	8	8 B. bomb. cl. II
Piekary	225 m	puddles on pasture	8	8 B. bomb. cl. I
Pisary	260 m	small pond near railway line	8	8 B. bomb. cl. II
Podłęże on r. Wisła	230 m	water gathered on meadow	10	9 B. bomb. cl. I, 1 B. varieg. cl. III
Poręba-Żegoty	240 m	puddles and small swamps	4	3 B. bomb. cl. I, 1 B. varieg. cl. III
Przeginia	230 m	loamy ditch	8	7 B. bomb. cl. II, 1 intermed.
Regulice	270 m	ditch near railway station	4	2 B. bomb. cl. III, 2 B. varieg. cl. III
Rozkochów	230 m	small ponds near r. Wisła	6	6 B. bomb. cl. I
Rudawa	240 m	small ponds near railway line	5	5 B. bomb. cl. II
Rusocice	230 m	puddles and old meander	10	7 B. bomb. cl. II, 3 B. varieg. cl. II
Rząska	240 m	pond near Pasternik	12	12 B. bomb. cl. II
Sanka	375 m	ponds in village	7	6 B. bomb. cl. II, 1 B. varieg. cl. III
Siersza	325 m	ponds near forest	8	8 B. bomb. cl. I
Szczyglice	235 m	small ponds near r. Rudawa	6	6 B. bomb. cl. I
Ściejowice	225 m	small ponds and puddles in village and on meadows	10	7 B. bomb. cl. I, 2 B. varieg. cl. III, 1 intermed.
Wołowice	225 m	small pond near road to Czernichów	4	3 B. bomb. cl. II, 1 B. varieg. cl. III
Zagacie	230 m	small swamp near highway	8	6 B. bomb. cl. II, 2 B. varieg. cl. III
Zwierzyniec	225 m	swampy meadow near road to Przegorzały	11	11 B. bomb. cl. I

List II

Localities in which no bombinators were found

Locality	approx. altitude	Ecological data	Date of survey	Remarks
Alwernia	300 m	O*	7. VII. 56	X**
Babice	270 m	O	20. VII. 57, 17. V. 58	X
Balice	260 m	O	29. VII. 56	X
Bolęcin	300 m	Many ponds and small ponds	17. V. 58, 16. VI. 58	17. V. X
Brzoskwinia	310 m	Pond in the village	2. VIII. 57, 14. V. 59	2.VIII X
Budzyń	220 m	A few puddles, not large	28. VII. 56	X
Chrosna	340 m	O	29. VII. 56	X
Czułów	270 m	O	3. V. 58	X
Czułówek	260 m	Small puddles (apparently there is a fish pond, not visited)	3. V. 58	X
Dulowa	310 m	Some small ponds and puddles along railway line	first half VIII. 57, 12. V. 58	12. V X
Frywałd	280 m	Large ponds in forest	29. VII. 56	X
Liszki	235 m	Small puddles near road	3. VI. 56	X
Morawica	270 m	O	29. VII. 56	X
Nawojowa Góra	270 m	Pond near forest	2. VIII. 57	X
Myślachowice	400 m	O	19. VII. 57	X
Nielepice	270 m	O	2. VIII. 57	X
Nowa Wieś Szlachecka	250 m	Rather numerous ponds and puddles	28. VII. 56	X
Płaza	385 m	O	17. V. 58, 16. VI. 58	X
Pogórzyce	340 m	Pond in village	20. VII. 57, 16. VI. 58	X
Puszcza Dulowska	300 m	Ditches with water along road and small swamps	17. V. 58, 16. VI. 58, 17. V. 59	17.V.58 X
Rudno	360 m	Rather numerous small ponds and puddles	first half VIII. 57, 12. V. 58	12. V. X

* „O" — no adequate habitats for Bombina sp. in the locality.

** „X" — in the given day Bombina sp. was seen or caught in other localities.

Locality	approx. altitude	Ecological data	Date of survey	Remarks
Rybna	260 m	Small ponds and swamps, especially near road to Chrzanów	3. VI. 56, 7. VII. 56, 3. V. 58	X
Stara Wola	295 m	A few small swamps	12. V. 58	X
Tenczynek	270 m	Some small swamps and pond closing by overgrowth	first half VIII. 57, 12. V. 58	12. V. X
Wygiełzów	270 m	Pond near forest	20. VII. 57, 17. V. 58	X
Zagórze	300 m	Numerous large and small ponds	17. V. 58	X
Zalas	340 m	0	3. VI. 56	X

Table II

Frequency of appearance of separate groups of bombinators in the investigated area

Species	number of specimens	class I	class II	class III
Bombina bombina (L.)	250	132	60	58
Bombina variegata (L.)	23	4	3	16
Intermediate form (cl. IV)	11	—	—	—
Total	284			

DISCUSSION

It results from an analysis of the material that the investigated area is inhabited principally by the lowland bombinator (*Bombina bombina* (L.)). The mountain bombinator (*Bombina variegata* (L.)) is represented by a few specimens, usually non-typical at that. However, alone the fact of finding them (Fig. 1), and on a comparatively low territory, too (e. g. Rusocice, circa 230 metres above sea-level), lying away from the mountains and separated from the Carpathian foot-hills by river Wisła and its affluents, is very important. The existence of the mountain bombinator in lower altitudes has been described by many

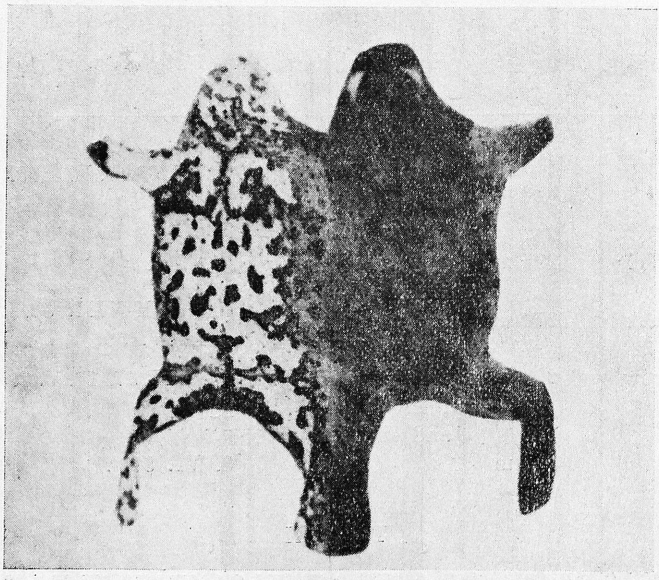


Fig. 1. *Bombina variegata* (L.) cl. I from the village Rusocice

scientists. They supposed that this bombinator avoids wide lowlands but may be found even in low altitudes on areas neighbouring with the mountains (Dueringen 1897, Mertens 1928, Buresch & Zonkow 1942, Terentev & Černov 1949, Michałowski 1958). The appearance of the mountain bombinator in parts of the Kraków—Chrzanów Ridge and the valley of river Wisła may be explained e. g. by the transport of larval forms, eggs, or adult specimens from the mountains onto lowlands by floods. This reasoning is used for instance by Pax (1921, 1925) in an attempt to explain an „isle"-like distribution of the mountain newt (*Triturus alpestris* Laurentus) in Lower Silesia. Changes of the course of river Wisła could also play a part in causing such a distribution of the bombinators; these changes may be either natural or caused by man (river course regulation — Ingarden 1916). In the Pleistocenian this river flowed through the Cholerzyn depression of to-day and directed its course to the northeast towards rivulet Rudawa. A trace of the old course changed naturally is found in the ground-waters circulating till to-day in this area (Pomianowski 1916, Jaszczurowski 1917, Ingar-

DEN 1917). During such changes of the course of river Wisła a part of the bombinator population living south of the river could be found north of the latter. Some part could also be played by active migrations of the bombinators. Juszczyk (personal communication) observed in Stanisławice near Bochnia a toad actively swimming across river Raba, rather wide in this place, and in Mszana Dolna a mountain bombinator swimming across the stream Mszanka. The results of the investigations, however, supplied no actual proof corroborating any of the enumerated hypotheses.

The reasons of a distribution in form of „islands" of the mountain bombinator in the investigated area should, as it seems, be sought for in the phylogeny of the bombinators, especially towards the end of the Pleistocenian. About 14 000 years ago, after the cool and forest-less Dryas period, there came the warmer Alleroed period in which conditions arose allowing the return of the bombinators from their Pleistocenian refuges. As the climatic conditions were still rather severe (the upper forest limit at the beginning of the Alleroed period being found as low as 250 metres above sea-level — SZAFER 1952a.), the first to invade could have the mountain bombinator as the more resistant species (e. g. in the Tatra Mts. it reaches the upper forest limit — FUDAKOWSKI 1957). It could then live only in the lowlands and in a part of the uplands. As the climate grew warmer during the Alleroed, and especially at the beginning of the Holocenian, there came conditions allowing the return of the lowland bombinator. The mountain bombinator could have reached the mountains and foot-hills at the time; however, it was extruded from the plains either completely or forming „isles" of distribution in some areas (e. g. the Kraków—Chrzanów Ridge), thus in relic localities (MICHAŁOWSKI 1959) of a post-glacial relic type (SZAFER 1952b.).

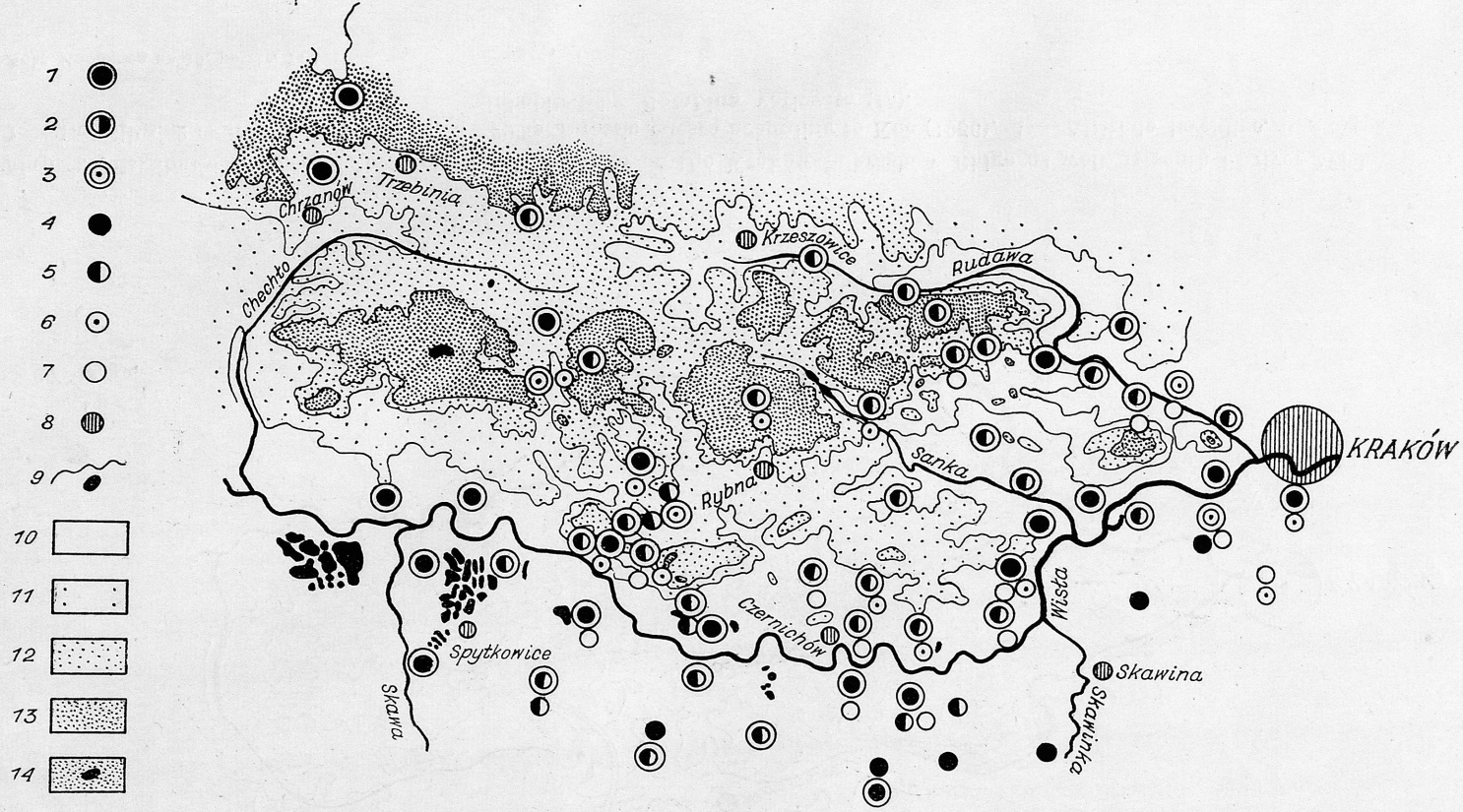
Similar views were held by HORBULEWICZ (1927, 1933) who supposed that the causes of the existing distribution of the bombinators are to be looked for in the history of the range of glaciation; according to this author the mountain bombinator primarily inhabited the Little-Polish Upland (Wyżyna Małopolska) and the Świętokrzyskie Mts., from where it could have been extruded by the lowland bombinator invading the

territory along river valleys. Map 2 illustrates a fact in conformance with the view of HORBULEWICZ (op. cit.), the existence of two areas of appearance of the mountain bombinator. These two areas are separated by the valley of river Wisła which could have been the zone of invasion of the lowland bombinator; however, it is no boundary in the distribution of bombinators as the individuals which inhabit the northern or southern part of the valley represent similar types (map 1).

It is interesing that the chief localities of the mountain bombinator are on the cuesta (KUC 1956) of the Jurassic limastone area. This cuesta at the same time forms the western boundary for this species in the described area.

The problem of a lack of bombinators in some parts of the investigated area arose during the collection of the material. In view of the remarks made in chapter „Material and methods" and the data of list II any objection based on the inaccuracy of the survey or the inadequacy of the catching period could hardly be justified. There may be several reasons for the lack of bombinators, namely (a) the investigated area is chiefly inhabited by the lowland bombinator, more exacting in respect to environment conditions, and many of the surveyed localities contained no ponds or puddles; (b) the altitude of a large part of the localities where the species was not found surpassed 300 metres above sea-level, i. e. an attitude rarely reached by the lowland bombinator; (c) the fact of a lack of bombinators in the western part of the area deserves attention, as this western part is not only rather high but also industrialised and possesses sandy soils.

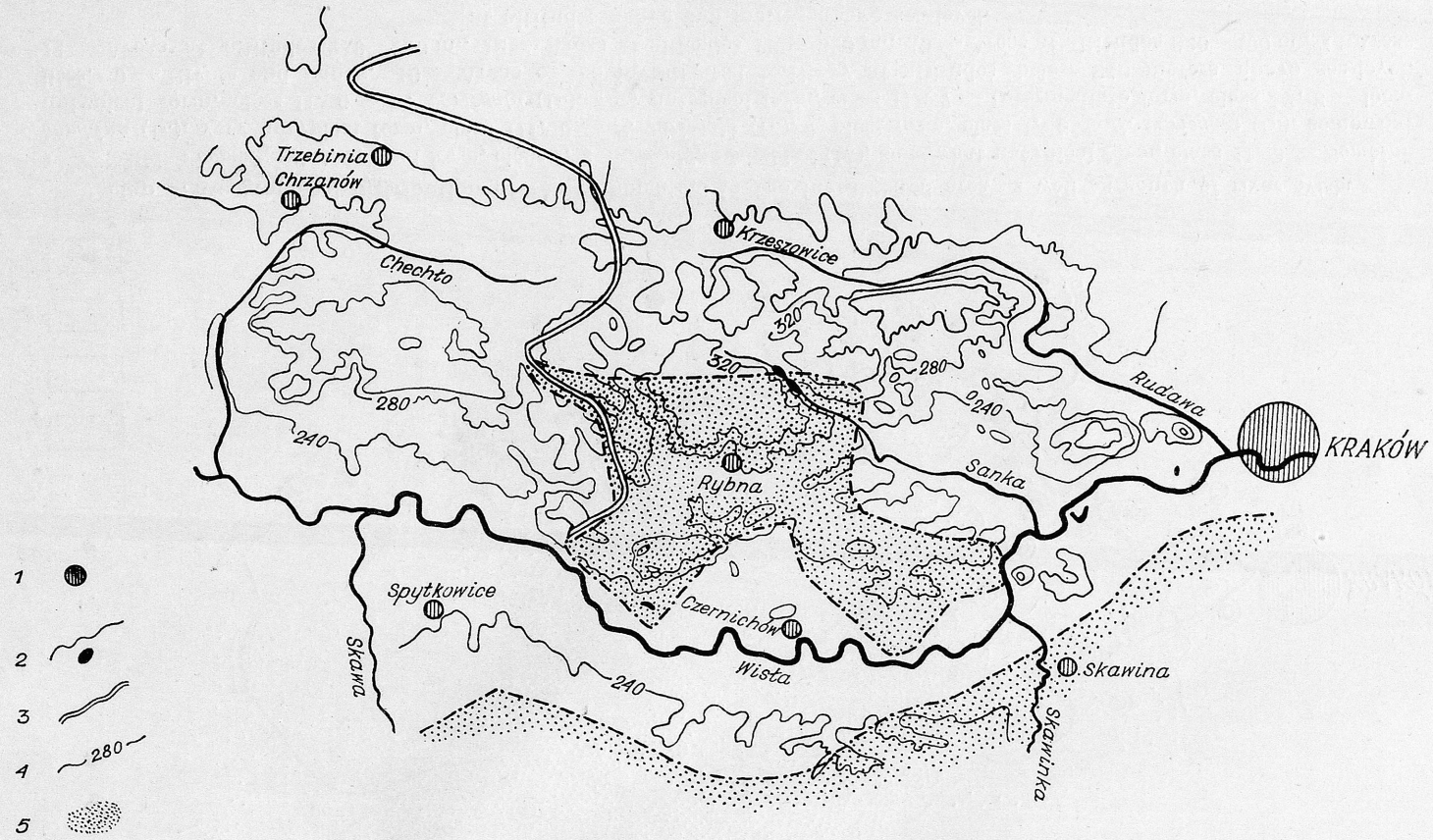
A study of the geographical distribution of the bombinators in this area, together with the former description of the distribution of these animals on the area between rivers Wisła, Skawa, and Raba (MICHAŁOWSKI 1958), brings further information on the bombinators in the environs of Kraków. The neighbouring parts of the Kraków—Częstochowa Jurassic area need investigation in the first place. They are most probably inhabited by the lowland bombinators; this is corroborated by the finding of lowland bombinators of class I north of Trzebinia by the author, as well as data from the literature (MERTENS 1928, BAYER 1937). JUSZCZYK (1939) quotes the lowland bom-



Map 1. Geographical distribution of the bombinators in the investigated area as well as south of river Wisła

1 — *Bombina bombina* (L.), typical form, class I, 2 — *Bombina bombina* (L.), somewhat untypical form, class II, 3 — *Bombina bombina* (L.), very untypical form, class III, 4 — *B. variegata* (L.), typical form, class I, 5 — *B. variegata* (L.), somewhat untypical form, class II, 6 — *B. variegata* (L.), very untypical form, class III, 7 — Intermediate form, class IV, 8 — localites, 9 — Rivers and ponds, 10 — Areas of the investigated territory at altitudes below 240 meters above sea-level, 11 — Areas at altitudes 240—280 m., 12 — Areas at altitudes 280—320 m., 13 — Areas at altitudes 320—400 m., 14-Areas at altitudes above 400 metres above sea-level.

Acta Zoologica nr 15, po str. 710



Map 2. Distribution ranges of the mountain bombinator on the Kraków—Chrzanów Ridge as well as south of river Wisła. 1 — Localites, 2 — Rivers and ponds, 3 — The Jurassic cuesta according to Kuc (1956), 4 — Altitude level-line, 5 — Area inhabited by Bombina variegata (L.).

binator from Biały Kościół and Żelków, and SZAFER & GOTKIEWICZ (1954) from Ojców. However, the species is probably not too frequent because of considerable altitudes and the dryness of this area.

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STRESZCZENIE

Badania przeprowadzono na obszarze ok. 520 km², obejmującym wzniesiony do 400 m n. p. m. Grzbiet Krakowsko-Chrzanowski i Dolinę Wisły. Miały one na celu poznanie rozsiedlenia kumaków na tym terenie, sprawdzenie danych o występowaniu kumaków górskich (Fejérváry 1923) i rozstrzygnięcie, czy płynąca równoleżnikowo Wisła stanowi jakąś granicę w rozmieszczeniu kumaków. Olbrzymią większość zebranego materiału stanowią kumaki nizinne, występujące w północnej i południowo-zachodniej części w dość czystej postaci. Znaleziono ponadto 23 okazy kumaka górskiego i 11 okazów o równocennych cechach obydwu gatunków. Ponieważ występują one wraz z kumakiem nizinnym w mieszanych stanowiskach, grupujących się w południowej części badanego terenu, dlatego też Dolina Wisły nosi charakter strefy mieszanej, podobnie

jak i w południowej swej części (MICHAŁOWSKI 1958). Przyczynami wystąpienia kumaka górskiego na tym terenie mogły być jego wędrówki czynne i bierne, jak też zmiany koryta Wisły, naturalne czy sztuczne. Autor najmocniej wiąże omawiane zjawisko z czynnikami epoki lodowej.

Jak wynika z analizy klimatycznej schyłku plejstocenu, kumaki górskie mogły zasiedlić równiny wcześniej niż kumaki nizinne. W miarę polepszania się warunków klimatycznych, kumaki górskie zajmowały pogórze i góry, równocześnie zaś postępująca na równinach inwazja kumaków nizinnych ograniczała ich zasięg do wyspowych stanowisk reliktowych.

W rejonie zachodnim nie znaleziono kumaków, co być może łączy się z takimi czynnikami jak: dość znaczne wzniesienie terenu, częsty brak zbiorników wodnych, uprzemysłowienie.

РЕЗЮМЕ

Исследования проводились на территории 520 кв. килом., вмещающей возвышающийся на 400 м. над уровнем моря Краковско-Хржановский Гребень и Долину Вислы. Целью этих исследований было изучение расселения жерлянок на этой территории, проверка данных, касающихся присутствия горных жерлянок (Фэервары, 1923) и разрешение вопроса, составляет ли проплывающая параллелю Висла какую-нибудь границу в расселении жерлянок. Громадное большинство собранного материала, это краснобрюхие жерлянки, встречающиеся в северной и югозападной части территории в довольно чистокровной форме. Найдено было 23 экземпляров желтобрюхой жерлянки и 11 экземпляров с равноценными признаками обоих видов. Так как они живут совместно с низменными жерлянками в смешанных местонахождениях, группирующихся в южной части исследуемой территории, вследствие этого Долина Вислы имеет характер смешанной полосы, равно, как и ее южная часть (Михаловский, 1958). Причиной появления горной жерлянки в этих местах, могли быть ее активные и пассивные миграции, а также натуральные и искуственные изменения в русле Вислы. Автор тесно вяжет описываемое явление с факторами ледникового периода. Из кли-

матического анализа конца плейстоцена следует, что желтобрюхие жерлянки могли заселять равнины раньше, чем низменные жерлянки. По мере улучшения климатических условий, желтобрюхие жерлянки занимали предгория и горы. Одновременно продвигающийся наплыв краснобрюхих жерлянок на равнины, ограничивал радиус заселения горных жерлянок до реликтовых островных местонахождений.

В западных районах жерлянки не были найдены. Быть может. что явление это находится в связи с такими факторами, как довольно значительная возвышенность местности, недостаток водоемов и индустриализация.

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