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INVESTIGATION OF THE GROWTH RATE OF TWO TERRESTRIAL SNAILS: *BRADYBAENA FRUTICUM* (O. F. MÜLLER) AND *EUOMPHALIA STRIGELLA* (DRAPARNAUD), PULMONATA – A *BRADYBAENA FRUTICUM* (O. F. MÜLLER) ÉS AZ *EUOMPHALIA STRIGELLA* (DRAPARNAUD) NÖVEKEDÉSÉNEK VIZSGÁLATA (GASTROPODA: PULMONATA)

ABSTRACT: Specimens collected in the field were measured and from the data second degree regression curves were constructed the different slopes of which show correlation with external factors.

Investigation of ontogeny is rather neglected in malacology. On other protostomia (Collembola, Coleoptera, Diptera, Lepidoptera) many investigations were performed. Having larval and pupal stages with different requirements the development of these organisms differs from that of the snails. Nevertheless, similar regularities appear in all these organisms: growth is influenced in a positive or a negative sense by the quality of the ingested food, the light, temperature and humidity of the medium and of the air. The growth rate of hygrophilous animals is promoted whereas that of xerophilous animals is retarded by increase of humidity (SCHWERDTFEGER, 1963). GERE (1978) established different growth curves for different taxonomic categories. FRÖMMING (1954) performed laboratory experiments on European terrestrial snails. Observing weight changes of *Helix pomatia* during 60 days he established that water output and water uptake erratically change through mucuos secretion.

The author's aim was to investigate the growth (increase of weight) of the two species in regionally different and locally identical surroundings and to make accessible the regularities of growth for ecological evaluation.

MATERIALS AND METHODS

Regularities of growth can be investigated in two ways: directly in connection with time (in culture vessels in laboratory or outdoors), and indirectly through mathematical calculations with the aid of second order regression. In the latter case calculation can be based on specimens randomly collected or on specimens collected in regular intervals (e. g., monthly) from a given area (e. g., 2.5 m^2). In the present study the latter method was used.

The regression curves based on individuals collected monthly from a given area show the growth in time and besides this through their different slopes the effect of external factors as well. The growth of animals of different size is influenced by the same external factors. This gives a possibility to correlate the ordinate points of the regression curves with the meteorogical data of the study area.

Two species of different humidity requirements were chosen. *Bradybaena fruticum* (O. F. MÜLLER 1774) is meso-hygrophilous, *Euomphalia strigella* (DRAPARNAUD 1801) is meso-xerophilous. On the basis of their occurence in Hungarian lowland forests (14 communities, 312 stands) using the abundance values (A/m^2) and the humidity indicating numbers from the mean frequency of plant species of the undergrowth regression calculations were performed. The humidity indicating values of herbaceous species were established by ZÓLYOMI *et al.* (1964). The regression lines and their equations show whether increase or decrease of humidity increases or decreases the A/m^2 value of the snails. These equations inform us about their requirements.

In a similar way was established the reaction of the species to the hydrological grade which expresses the height of the water table as related to its height in April. This was determined by the method of BABÓS (1966) used in the pedological laboratories of forestries.

The regression lines of the humidity grade and of the hydrological type served as control of the investigation of growth rate of the two species (Figs 1 and 2). On the Figures the results of the correlation calculations to humidity (1) and to hydrological grade (2) are also seen: N = number of cases, r = correlation coefficient, P % = significance level, the a and the b values of the equation $y = a + bx$ and the limits of the confidence interval (S_a and S_b). The calculations were performed with a Wang-600 computer.

To investigate growth rate 99-108 living specimens of *Bradybaena* were collected randomly in three forests belonging to two forest types: 1. the Páhi forest, 25. 6. 1981., humidity grade 7; 2. the Tabdi forest, 30. 7. 1973., humidity grade 6. They are situated in the Kiskunság National Park. Both belong to Fraxino pannonicae – Alnetum hungaricum SOÓ et KOMLÓDI 1968, alliance Alnion glutinosae MALCUIT 1929. 3. Sárkánykert (2 km

Bradybaena fruticum (O.F. Müll.)

	a Sa	b Sb
1	- 9.24 ± 2.92	2.86 ± 0.49
2	-44.02 ± 5.0	12.17 ± 1.13

$y = a + bx$

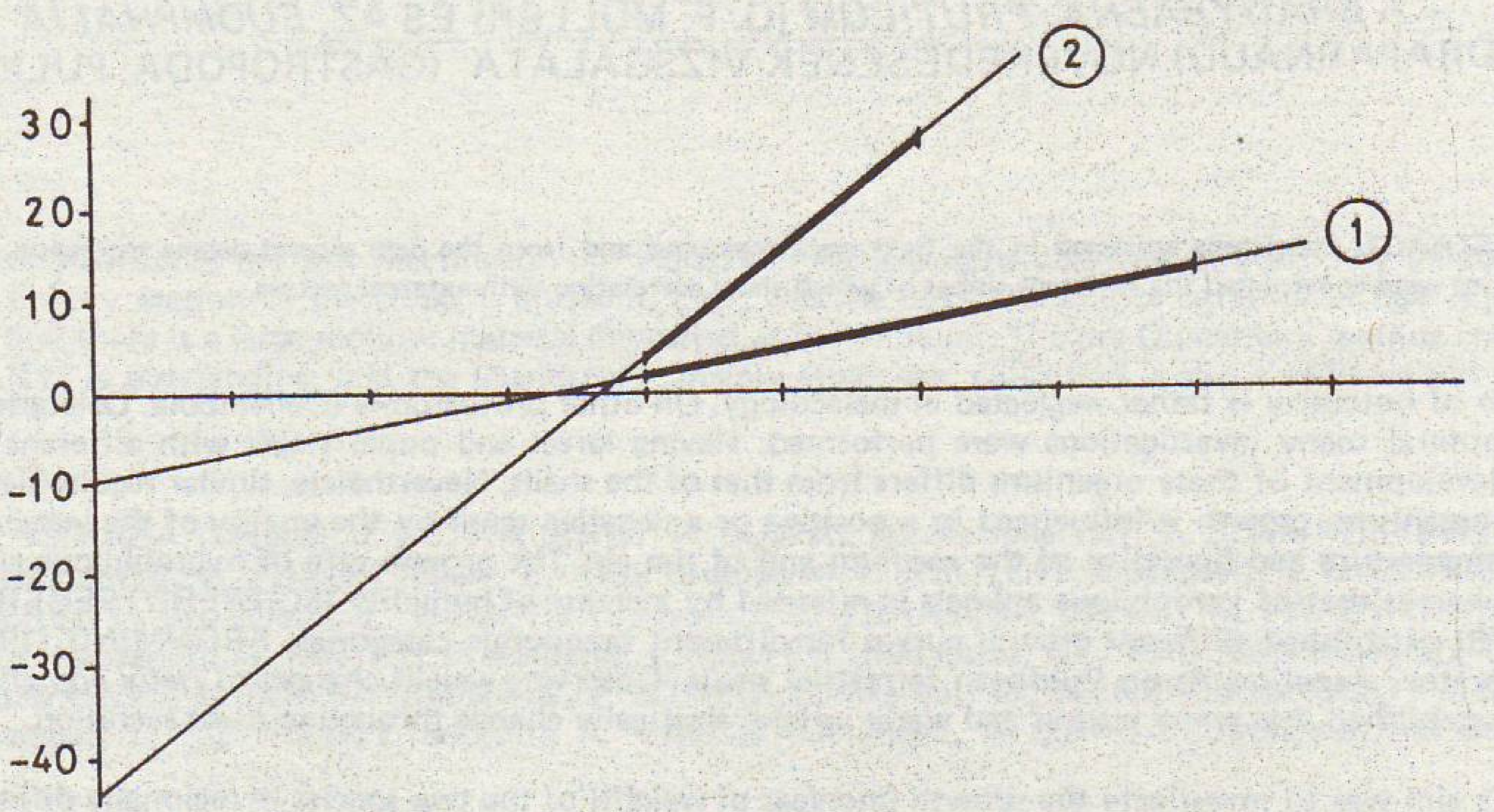


FIG. 1. Second order regression curves of *Bradybaena fruticum* in relation to humidity (1) and to hydrobiological type (2). On the y axis number of individuals per m^2, on the x axis grades of humidity (8) and hydrobiological types (6). (BABÓS *et al.*, 1966; ZÓLYOMI *et al.*, 1964).

Euomphalia strigella (Drap.)

	a Sa	b Sb
1	3.29 ± 0.26	-0.40 ± 0.04
2	- 1.40 ± 0.69	0.76 ± 0.16

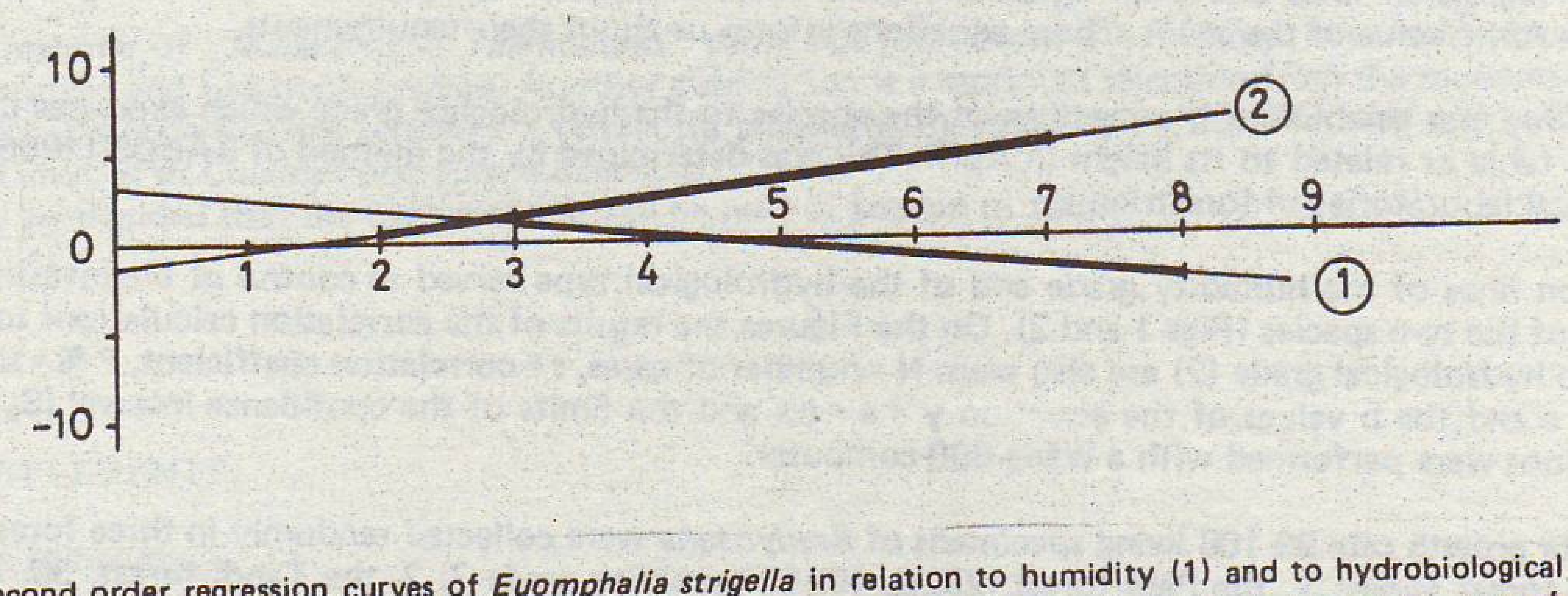
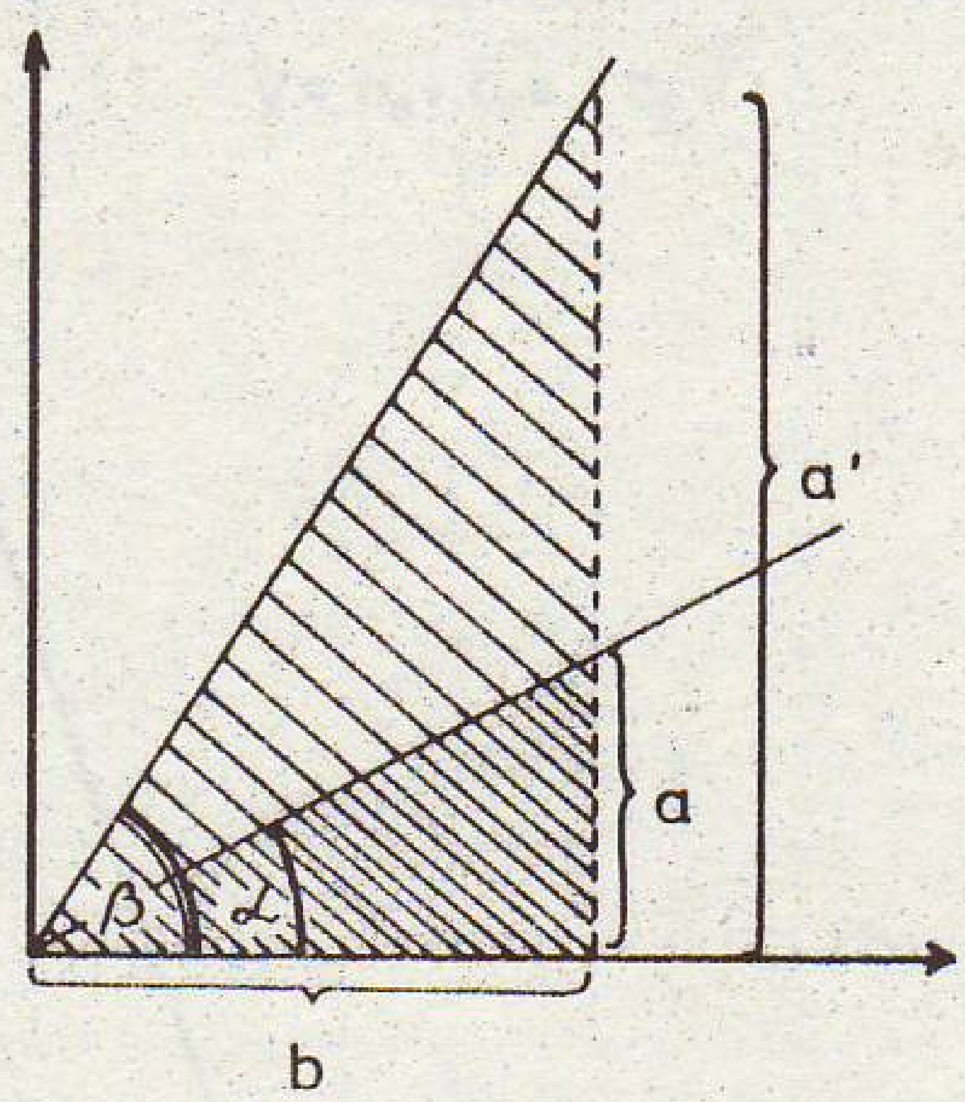


FIG. 2. Second order regression curves of *Euomphalia strigella* in relation to humidity (1) and to hydrobiological types (2). On the y axis number of individuals per m^2, on the x axis grades of humidity (8) and hydrobiological types (6). (BABÓS *et al.*, 1966; ZÓLYOMI *et al.*, 1964).

from Vásárosnamény, county Szabolcs-Szatmár) 19. 7. 1978., Salicetum albae-fragilis ISSLER 1926, alliance Salicion triandrae MÜLLER-GÖRS 1958.

Euomphalia specimens were collected in 3. 5., 3. 6. 1980., 3. 5., 3. 7., 3. 8., 3. 9. 1981., each time from hundred collateral 25 x 25 cm^2 quadrats in an oak forest influenced by culture (Nagyerdő, Szabadkígyós in county Békés; it is a part of a reserve grown on a solonetz meadow chernozem).



$$tg\alpha = \frac{a}{b} \qquad tg\beta = \frac{a'}{b}$$

FIG. 3. Calculation of the rate of change of weight with the aid of elementary lines.

Shell height was measured for both species. According to former investigations, the growth rate of height significantly changes with humidity (BÁBA, 1971). Regression calculations were performed with the weights belonging to the height of the individuals given. The letters in the resulting second degree regression equations ($y = b_0 + b_1x + b_2x^2$) correspond to those used earlier (Figs 4 and 5).

On the second degree curves slope is expressed by the tangent of the angle formed with the horizontal axis:

$$tg\,\alpha = \frac{\text{perpendicular opposite to the angle}}{\text{perpendicular adjacent to the angle}}$$

All curves (and so the growth curves) can be approximated by elementary lines. The angle of these linear sections formed with the horizontal axis shows the change of weight (Fig. 3):

$$tg\,\alpha = \frac{\text{change of weight}}{\text{1 mm height of the shell}}$$

On the section where tg_α is higher the growth is more intensive. The second order curves showing growth were calculated on the basis of the measurements. From the curves weight values belonging to each height can be obtained. Calculations of tg_α indicating changes in growth intensity were performed using the coordinates. Tangents are negative only when weight decreases.

Tables 1 and 2 contain the coordinates of the second degree equations, the tangent of the angles, and the percentile differences in weight calculated from the tangents. The percentile weight differences diminished by 100 give the per cent of weight increase between the two stages. For example,

$$0.0020 \xrightarrow{\text{growth}} 0.0026$$

$$\frac{0.0020}{100} = 0.000020$$

$$\frac{0.0026}{0.000020} = \frac{2600}{20} = 130\,\%$$

$$\frac{-\,100}{+\;30\,\%}$$

		r	P%	b_0 S_a	b_1 S_b	b_2 S_{b_2}	N	S
1	25.VI.1981	0.96	0.1	-0.19±0.018	0.005±0.021	0.007±0.005	108	0.208
2	30.VII.1973	0.99	0.1	0.34±0.048	-0.075±0.023	0.008±0.09	108	0.768
3	19.VII.1978	0.98	0.1	0.94±0.011	-0.19 ±0.018	0.013±0.003	99	0.528

$$y = b_0 + b_1x + b_2x^2$$

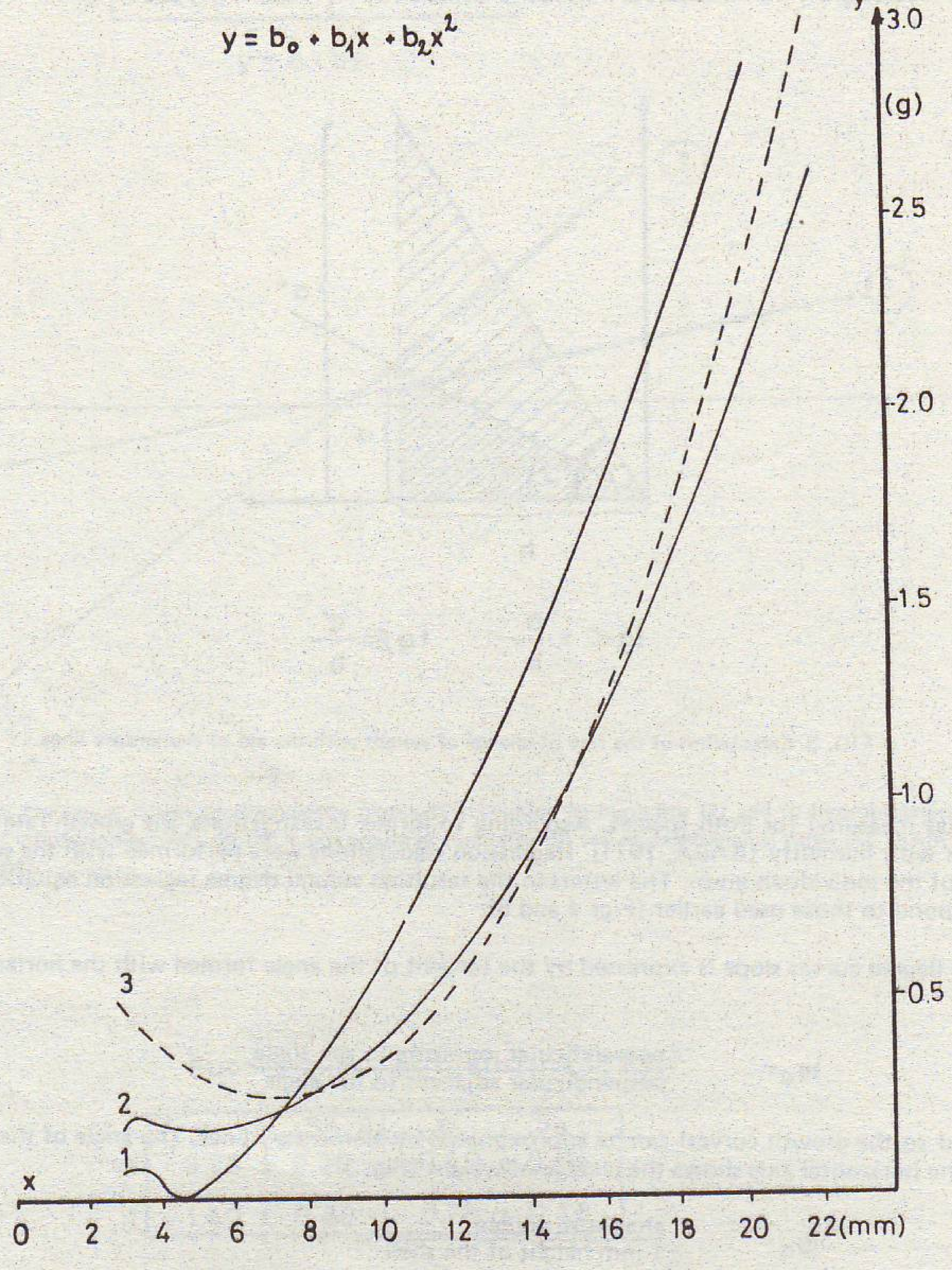


FIG. 4. Height (x) and weight (y) of *Bradybaena fruticum* as depending on rising humidity of the habitat. 1. Forest of Páhi, 2. Forest of Tabdi, 3. Forest of Sárkánykert. r = correlation coefficient; P % = significance level; N = number of cases; b_0, b_1, and b_2 = coefficients of the regression equation and their error (S_a, S_b, and S_{b2}), and S = error of the equation.

In 1980 and 1981 climatic measurements were taken on the area of Szabadkígyós. The monthly means (broken down into three days) were correlated with the data of the ordinates of the second degree regression equations calculated for each month. Calculations were performed with the data of precipitation, temperature of the air, and the temperature of air near the soil to obtain linear, exponential and power-functional correlations to establish which factor has a role in the increase of weight. Climatic data broken down into three days means are seen in Table 3. The author is indebted to the climatologist BÉLA SUGÁR for these data.

		r	P°/o	b_0 S_a	b_1 S_b	b_2 S_{b_2}	N	S
1	3. V. 1980	0.98	0.1	0.073±0.019	-0.049±0.006	0.010±0.0005	95	
2	3. VI.1980	0.95	0.1	0.048±0.076	-0.035±0.023	0.009±0.0015	129	
3	3. V. 1981	0.89	0.1	0.133±0.089	-0.057±0.032	0.010±0.002	79	
4	3. VII.1981	0.96	0.1	0.368	-0.135	1.801	72	0.79
5	3. VIII.1981	0.96	0.1	0.104±0.7	-0.048	0.009	39	0.75
6	3. IX. 1981	0.94	0.1	-0.081±0.018	0.050±0.018	0.002±0.0015	92	

$$y = b_0 + b_1 x + b_2 x^2$$

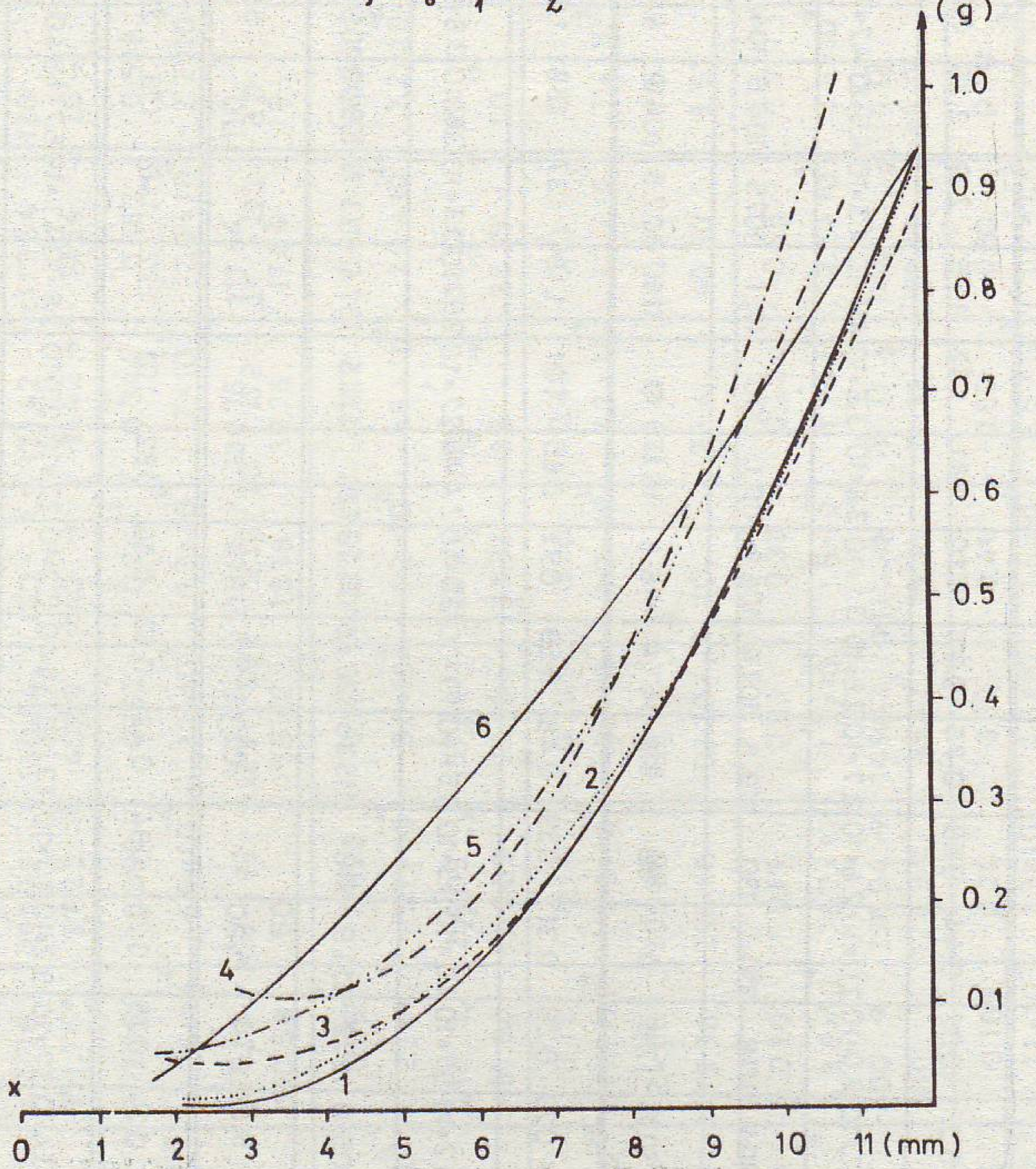


FIG. 5. Relation between height (x) and weight (y) of *Euomphalia strigella* in different months of different years.

RESULTS AND DISCUSSION

The two species differ in relation to humidity of the soil surface (Figs 1 and 2, line 1) and to hydrological grade established on the water level (Figs 1 and 2, line 2). Growth of *Bradybaena* increases with the humidity determining factors (Figs 1 and 2). Abundance values of *Euomphalia* decrease with the humidity determining factors. The regression lines clearly show the differences between the two species in habitat requirements according to which in the Hungarian Plain *Bradybaena* occurs in the humid forests while *Euomphalia* occurs under semi-arid conditions similar to those of the Nagyerdő. *Euomphalia* was a characteristic species of the tundra aera (ANT, 1963) due to its lower humidity demands.

TABLE 1. Increase of weight of *Bradybaena fruticum* in three forests with different humidity level. a) co-ordinates, b) tg_{α} , c) growth per cent as related to the initial stage, d) differences of growth per cents.

	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. a.	0.05	0.03	0.02	0.1	0.2	0.32	0.44	0.59	0.75	0.92	1.10	1.31	1.52	1.75	2.0	2.26	2.53	2.82	3.12	3.44
b.		-3.4×10^{-4}	-1.7×10^{-4}	1.3×10^{-3}	1.7×10^{-3}	2.0×10^{-3}	2.0×10^{-3}	2.6×10^{-3}	2.7×10^{-3}	2.9×10^{-3}	3.1×10^{-3}	3.6×10^{-3}	3.6×10^{-3}	4.0×10^{-3}	4.3×10^{-3}	4.5×10^{-3}	4.7×10^{-3}	5.0×10^{-3}	5.2×10^{-3}	5.5×10^{-3}
c.			200	130.7	130.7	117.6	100	130	103.8	107.4	106.8	116.1	100	111.1	107.5	104.6	104.4	106.3	104	105.7
d.			-10.0	30.7	30.7	17.6	0	30	3.8	7.4	6.8	16.1	0	11.1	7.5	4.6	4.4	6.3	4.0	5.7
2. a.	0.18	0.16	0.16	0.17	0.20	0.25	0.31	0.39	0.48	0.59	0.71	0.85	1.01	1.18	1.37	1.58	1.80	2.04	2.29	2.57
b.		$-3.4\ 10^{-4}$	0	1.7×10^{-4}	5.2×10^{-4}	8.7×10^{-4}	1.0×10^{-3}	1.3×10^{-3}	1.5×10^{-3}	1.9×10^{-3}	2.0×10^{-3}	2.4×10^{-3}	2.7×10^{-3}	2.9×10^{-3}	3.3×10^{-3}	3.6×10^{-3}	3.8×10^{-3}	4.1×10^{-3}	4.3×10^{-3}	4.7×10^{-3}
c.			0	50	305.8	167.3	114.9	130	115.38	126.66	105.26	120	112.5	107.4	113.79	109.09	105.55	107.89	104.87	109.30
d.			0	50	5.8	67.3	14.9	30	15.3	26.6	5.26	20	12.5	7.4	13.7	9.0	5.5	7.8	4.8	9.3
3. a.	0.48	0.38	0.31	0.26	0.24	0.25	0.28	0.34	0.42	0.53	0.66	0.82	1.01	1.22	1.46	1.73	2.02	2.34	2.68	3.05
b.		-1.7×10^{-3}	-12×10^{-3}	8.7×10^{-4}	-3.4×10^{-4}	1.7×10^{-4}	5.2×10^{-4}	1.0×10^{-3}	1.3×10^{-3}	1.5×10^{-3}	2.2×10^{-3}	2.7×10^{-3}	3.3×10^{-3}	3.6×10^{-3}	4.1×10^{-3}	5.7×10^{-3}	4.0×10^{-3}	5.5×10^{-3}	5.9×10^{-3}	6.4×10^{-3}
c.			-70.58	-72.5	39.08	50	294.11	200	130	146.15	115.78	122.72	122.22	109.09	113.88	139.02	70.17	137.5	107.27	108.47
d.			-29.4	-27.5	-60.9	50	94.1	100	30	46.1	15.78	22.7	22.2	9.09	13.8	39.02	-29.82	37.5	7.2	8.47

TABLE 2. Increase of weight in *Euomphalia strigella* of various heights in the Nagyerdő of county Békés in different months of 1980 and 1981. a) co-ordinates, b) tg_{α}, c) growth per cent as related to the initial stage, d) differences of growth per cents.

1		2	3	4	5	6	7	8	9	10	11	12
V. 1980	a	0.015	0.016	0.037	0.078	0.139	0.22	0.32	0.44	0.58	0.74	0.92
	b		1.7×10^{-4}	3.6×10^{-4}	7.1×10^{-4}	10.0×10^{-3}	1.4×10^{-3}	1.7×10^{-3}	2.0×10^{-3}	2.4×10^{-3}	2.7×10^{-3}	3.1×10^{-3}
	c			211.76	197.22	140.84	140	121.42	117.64	120	112.5	114.81
	d			111.76	97.22	40.84	40	21.42	17.64	20	12.5	14.81
VI. 1980	a	0.04	0.024	0.052	0.092	0.162	0.244	0.344	0.462	0.598	0.752	0.924
	b		1.7×10^{-4}	4.6×10^{-4}	6.9×10^{-4}	1.1×10^{-3}	1.3×10^{-3}	1.7×10^{-3}	2.0×10^{-3}	2.2×10^{-3}	2.7×10^{-3}	2.9×10^{-3}
	c			270.58	150	159.42	118.18	130.76	117.64	110	122.72	107.40
	d			170.58	50	59.42	18.18	30.76	17.64	10	22.72	7.40
V. 1981	a	0.059	0.052	0.065	0.098	0.151	0.224	0.317	0.43	0.56	0.71	0.88
	b		-1.2×10^{-3}	2.2×10^{-4}	5.7×10^{-4}	9.0×10^{-4}	1.2×10^{-3}	1.5×10^{-3}	2.0×10^{-3}	2.2×10^{-3}	2.6×10^{-3}	2.9×10^{-3}
	c			18.33	259.09	157.89	133.33	125	133.33	110	118.18	111.53
	d			-81.66	159.09	57.89	33.33	25	33.33	10	18.18	11.53
VII. 1981	a	0.16	0.12	0.11	0.14	0.20	0.30	0.43	0.61	0.81	1.06	
	b		-6.9×10^{-4}	-1.7×10^{-4}	5.2×10^{-4}	1.0×10^{-3}	1.7×10^{-3}	2.2×10^{-3}	3.1×10^{-3}	3.4×10^{-3}	4.3×10^{-3}	
	c			24.63	305.88	192.30	170	129.41	140.90	109.67	126.47	
	d			-75.36	205.88	92.30	70	29.41	40.90	9.67	26.47	
VIII. 1981	a	0.067	0.078	0.10	0.15	0.23	0.32	0.42	0.55	0.70	0.87	
	b		1.9×10^{-4}	3.8×10^{-4}	8.7×10^{-4}	1.3×10^{-3}	1.5×10^{-3}	1.7×10^{-3}	2.2×10^{-3}	2.6×10^{-3}	2.9×10^{-3}	
	c			200	228.94	149.42	115.38	113.33	129.41	118.18	111.53	
	d			100	128.94	49.42	15.38	13.33	29.41	18.18	11.53	
IX. 1981	a	0.0306	0.095	0.165	0.24	0.32	0.41	0.50	0.60	0.70	0.81	0.93
	b		1.1×10^{-3}	1.1×10^{-3}	1.3×10^{-3}	1.3×10^{-3}	1.5×10^{-3}	1.5×10^{-3}	1.7×10^{-3}	1.7×10^{-3}	1.9×10^{-3}	2.0×10^{-3}
	c			100	118.18	100	115.38	100	113.33	100	117.76	105.26
	d			0	18.18	0	15.38	0	13.33	0	11.75	5.26

TABLE 3. Climatic data of the Nagyerdő of Szabadkigyós (1. precipitation mm. 2. temperature of air ^{o}C. 3. temperature of soil at 2 cm (in mean of three days). 4. Monthly sum of precipitation and temperature's averages. 5. Yearly averages).

Date	No	Day	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-31	4.	5.
V. 1980	1		-	20.1	4.5	2.5	-	9.3	1.4	7.4	-	28.9	74.1	1980
	2		13.2	11.6	14.3	12.5	9.3	12.1	13.3	11.2	14.8	18.0	13.2	
	3		14.7	13.2	16.0	13.0	12.8	13.9	15.4	14.8	16.0	19.7	15.6	611.2mm
VI.1980	1		5.8	13.1	16.6	15.2	-	-	0.1	14.5	7.6	2.9	75.8	9.1 °C
	2		13.8	14.9	16.7	18.9	22.0	19.9	17.9	21.3	17.5	15.5	17.9	10.7 °C
	3		15.5	15.5	18.9	20.6	24.4	24.1	22.7	24.2	20.2	12.1	20.3	
V. 1981	1		13.0	11.7	-	0.7	8.7	-	3.9	-	-	0.5	38.5	1981
	2		10.7	10.8	13.2	15.8	15.2	16.4	15.9	17.0	21.4	18.6	15.6	
	3		11.6	11.4	14.3	18.9	18.0	20.7	20.6	21.4	23.8	21.8	18.4	
VII.1981	1		-	30.5	-	0.1	5.4	-	9.9	-	3.1	15.5	64.5	579.9mm
	2		19.5	18.0	18.8	22.4	21.5	21.3	17.9	21.5	19.5	17.8	23.9	10.2 °C
	3		25.3	21.0	23.9	26.7	26.4	25.6	21.1	25.1	24.3	20.4	23.9	11.9 °C
VIII. 1981	1		-	-	3.0	6.2	0.3	1.4	4.3	3.2	3.5	0.9	22.8	
	2		24.3	23.0	24.5	22.5	20.4	20.3	18.8	15.5	15.2	14.4	19.7	
	3		27.5	28.3	28.9	26.3	25.0	25.3	24.3	18.7	18.1	16.8	23.7	
IX. 1981	1		19.5	0.3	-	0.8	2.1	-	0.1	0.5	3.3	30.0	56.6	
	2		17.2	15.9	17.4	17.4	14.5	12.1	18.1	20.9	18.6	18.2	17.0	
	3		18.6	18.1	20.8	19.6	17.7	15.3	18.8	22.2	19.9	19.2	19.0	

TABLE 4. 1. Percentile increase of *Bradybaena* and *Euomphalia* to the end state measured from the beginning. 2. Percentile increase of weight measured to arrival at sexual maturity. 3. Increase of weight measured to arrival at sexual maturity as per cent of the increase of weight to the end state.

Euomphalia strigella	1.	2.	3.
V. 1980.	6133.33%	2933.33%	47.82
VI. 1980	6600	3285.71	49.78
V. 1981	1491.52	728.81	48.86
VII. 1981	662.50	1381.25	57.54
VIII. 1981	1298.50	820.89	63.21
IX. 1981	3039.21	1660.78	64.51
Bradybaena fruticum			
Páhi	6880	2620	38.08
Tabdi	1422.22	372.22	33.20
Sárkánykert	635.41	170.83	26.88

Curves drawn on the basis of the second degree regression equations (Figs 4 and 5) – in the case of *Bradybaena* in different habitats and in the case of *Euomphalia* in different months – are of identical type for both species.

The intensity of weight increase is different in the two species and this can be attributed partly to the different habitats (*Bradybaena*) and partly to the monthly changing climatic factors (*Euomphalia*). The differences are best expressed by the different percentage of increase in *Euomphalia* in the same month (May) of 1980 and 1981 (Table 2, line d).

Development in both species starts with different initial weights. The weight of ovules deposited at different times and in different habitats are different. In the case of *Bradybaena* the highest initial weights can be observed at the humidity grade 5 (Fig. 4, curve 3). In the case of *Euomphalia* the highest initial weights were registered in May-August 1981 (Fig. 5, curves 1 and 4). This might be attributed to the low precipitation at the beginning of the vegetation period in 1981 and to the higher temperature of air and soil in the same period (Table 3).

The initial growth rate is followed by a transient decrease of it in both species. This decrease is higher when the initial weight was lower. Probably this is the cause of the higher mortality of young animals. Measure of decrease manifests itself by *Bradybaena* with intensive fluctuations. The cause of the decrease should be searched in the feeding possibilities of the freshly hatched animals. In the case of *Euomphalia* a decrease of temperature was observed after hatching (Table 3). Decrease of temperature causes a decrease or even a stop of feeding as observed in laboratory experiments. Influence of temperature on feeding can explain in the case of *Euomphalia* the stop of the increase of weight in the ninth month (Table 2 and the meteorological data of line 3 in Table 3).

The percentile increase is high in both species till the 4-5 mm state, thereafter it decreases. In *Bradybaena* specimens of 12-14 mm size and in *Euomphalia* specimens of 7-9 mm size another increase of the growth rate can be observed (Tables 1 and 2, lines c and d). According to FRÖMMING (1954), *Bradybaena* reaches sexual maturity in 13-14 months. Sexual maturity is delayed in laboratory specimens. The author attributes the increased growth a *Bradybaena* at the 12-14 mm state to the arrival of sexual maturity. Similarly can be evaluated the increased growth of *Euomphalia* at the 7-9 mm state.

Besides the proportionality factors of the equations (Figs 4 and 5, a, b_1, b_2) the increased growth rate at the time of arrival at sexual maturity specifies the character of growth.

In both species the tendency of growth is similar also in the sense that the rate of weight increase decreases with the age and with the increase of height (Tables 1 and 2, line d); this tendency agrees with GERE s (1978) observations according to which animals of Blattidae, Orthoptera, Lepidoptera, Aves and Mammalia grow slower in the second phase of their development than in the first one.

Table 4 shows how many times is increased the weight of the animal from the beginning till the measured end state and till arrival at sexual maturity.

TABLE 5. Values of correlation coefficients and probabilities in different transformations

1. Linear correlation	r = 0.14	probability 46%
2. Exponential correlation	r = 0.17	probability 65%
3. Power function	r = 0.32	probability 97%

It can be established that after a lower initial weight the growth rate is higher and after a higher initial weight it is lower as exhibited by *Euomphalia* in the seventh and eighth month of 1981 and by *Bradybaena* in the habitat of humidity degree 5 in Sárkánykert. In the case of favourable external conditions and high initial weights increase as related to the initial weight is lower than in the oposite case.

According to Table 4, it seems that increase till the arrival at sexual maturity is characteristic of the species although in this respect further investigations are needed.

The tendency of weight increase is very high in both species. This indicates that due to the great quantity of ingested food they have an important role in the catabolic processes; on the other side they intensively multiply and through this they offer themselves to consument animals, among others amphibia and mammals (BÁBA, 1975).

Investigating the cause of the fluctuating growth rate correlations were calculated between changing weight and meteorological factors of Table 3. According to FRÖMMING (1954), fluctuation of the weight of *Helix pomatia* is caused by changing water uptake and water output. But he did not mention the cause of this change. Correlation with the climatic data brings us nearer to the solution of this problem. The author found positive correlation between the calculated ordinate values of *Euomphalia* and the temperature of the soil. Fluctuation in the increase of weight is induced by changes in the soil temperature measured at 2 cm. Cold and warm fronts produce changes in temperature and through this in the feeding of the soil inhabiting *Euomphalia* and consequently its increase of weight becomes also changing. A little higher soil temperature induces an exponentially higher increase of weight.

ÖSSZEFOGLALÁS

A szerző indirekt módon, matematikai úton, regressziós számításokkal vizsgálta két csigafaj növekedését súlygyarapodást mérve. A másodfokú regressziós görbék a növekedés időbeli kapcsolatait és a növekedésre ható külső tényezők szerepét egyaránt tükrözik, mintegy azok „lenyomatai". A másodfokú regressziós görbék pontjainak koordinátáit a területen folyamatosan mért klimatikus adatokkal hozta összefüggésbe. Kontrollként vizsgálta a két faj nedvességgel és a talaj hidrológiai fokozatával szembeni viselkedését is, elsőfokú regressziós számításokkal.

REFERENCES

ANT, H. (1963): Faunistische, ökologische und tiergeographische Untersuchungen zur Verbreitung der Landschnecken in Nordwestdeutschland. Abh. Landesmus. Naturk., Münster, 25: 1-125. – BÁBA, K. (1971): Elterjedési és ökológiai adatok a *Bradybaena fruticum* O. F. MÜLLER hazai előfordulásához. A Szegedi Tanárképző Főiskola Tud. Közl., II: 89-98. – BÁBA, K. (1975a): Erdők állapotának minősítési lehetőségei. A Juhász Gyula Tanárképző Főiskola Tud. Közl., II: 37-51. – BÁBA, K. (1975b): Csigákat fogyasztó gerincesek. A csigák állati eredetű táplálékai. Soosiana, 3: 37-51. – BABÓS, I., HORVÁTH, ..., JÁRÓ, Z., KIRÁLY, I., SZODFRIDT, I. and TÓTH, B. (1966): Erdészeti termőhelyfeltárás és térképezés. Akadémiai Kiadó, Budapest, pp. 1--283. – FRÖMMING, E. (1954): Biologie der mitteleuropäischen Landgastropoden. Duncker-Humblot, 404 pp., 6 Pls. Berlin. – GERE, G. (1978): Szárazföldi ízeltlábúak és gerincesek produktivitásának alaptípusai. D. Sc. Thesis, Budapest, 1-152. SCHWERDFEGER, F. (1963): Ökologie der Tiere. Aut-ökologie. Verlag Paul Parey, 461 pp., 271 Pls., Hamburg-Berlin. – ZÓLYOMI, B., BARÁTH, Z., FEKETE, G., JAKUCS, P., KÁRPÁTI, I., KÁRPÁTI, V., KOVÁCS, M. und MÁTÉ, Z. (1964): Einreihung von 1400 Arten der ungarischen Flora in ökologische Gruppen nach TWR-Zahlen. Fragmenta Botanica Musei Historico-Nat. Hungarici, 4: 101-143.

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