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GROWTH RATE OF THE *CARABUS* L. LARVAE (COL., CARABIDAE)*

ABSTRACT: Rate of dry body weight increase of larvae of three *Carabus* species was calculated on the basis of field sampled individuals. This rate appeared to be similar to the rate of body weight increase of teneral beetles of the same species.

Contents

1. Introduction
2. Results
3. Conclusions
4. Summary
5. Polish summary (Streszczenie)
6. References

1. INTRODUCTION

The present author has previously shown (Grüm 1973b) that – apart from body weight increase of larvae – a rapid body weight increase of newly hatched carabid beetles occurs in the first 2–3 weeks of their lives. This paper is focused on estimates of body weight increase of larvae of *Carabus*, and on comparison of its rate to that of the teneral beetles.

The investigations were carried out in two woodland habitats in which *Pino-Quercetum* and *Tilio-Carpinetum* associations predominated (the habitats were located in the east part of the Kampinos Forest, several kilometers north-west from Warsaw) from the 27th of April 1972 till the 30th of August 1973. The larvae were captured in pitfalls with openings dug deep down to the borderline between litter layer and soil. The larva species were determined, head width of the larvae measured exactly to 0.01 mm, and the larvae were oven dried at 65° C to constant weight.

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2. RESULTS

Totally, 152 larvae of the three following species were studied: *Carabus nemoralis* Müll. (101 individuals), *C. glabratus* Payk. (34 individuals) and *C. arcensis* Hbst. (17 individuals).

Larval instars of *C. nemoralis* and *C. glabratus* were distinguished on the grounds of the head width distribution (Fig. 1). Mean values of head width of separate instars of the larvae (Tab. I) were slightly smaller than the values found by Luff (1969) for the same species inhabiting Great Britain (the differences varied from 0.5 to 14.5%). Larval instars of *C. arcensis* were distinguished according to the head width values of the British population of this species (Luff 1969).

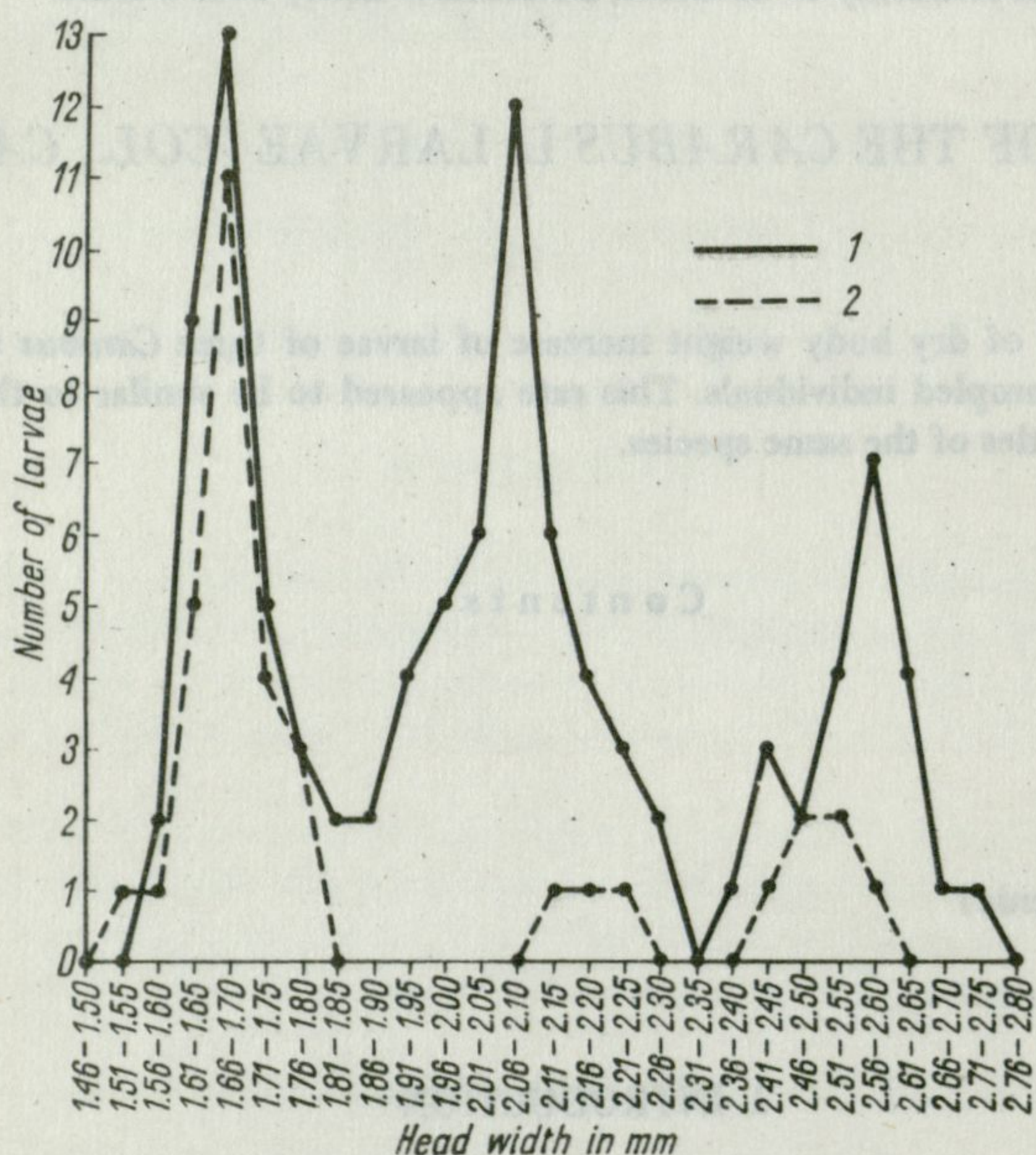


Fig. 1. Head width distribution

1 — *C. nemoralis*, 2 — *C. glabratus*

Tab. I. Head widths

Species	Instar	Number of larvae	Mean (mm)	Range (mm)
<i>C. nemoralis</i>	Ist	34	1.69	1.56–1.85
	IIInd	44	2.07	1.86–2.30
	IIIrd	23	2.54	2.38–2.73
<i>C. glabratus</i>	Ist	25	1.68	1.54–1.80
	IIInd	3	2.17	2.12–2.21
	IIIrd	6	2.49	2.41–2.57

Dry body weights of larvae of a given instar seem to be very variable (Tab. II). This variability is independent of the head width, as indicated by the following correlation coefficients: +0.235, +0.249 and -0.030 calculated for the IIInd and the IIIrd larva instar of *C. nemoralis*, and the Ist instar of *C. glabratus*, respectively. The only exception is the correlation coefficient calculated for the Ist instar larvae of *C. nemoralis*: +0.620 ($P > 0.05$). It seems probable, that this high variability of dry body weight of larvae of an instar – being independent of the head width – is caused by different amounts of food in the larva alimentary tracts.

Tab. II. Dry body weight estimates

Species	Stage in the life-cycle	Number of individuals	Mean (mg)	Range (mg)
<i>C. nemoralis</i>	adult beetles	22	166.0	138.1–196.1
	teneral beetles	15	45.4	36.8– 82.7
	IIIrd instar larvae	23	29.5	19.1– 48.3
	IIInd instar larvae	44	12.6	5.7– 28.2
	Ist instar larvae	34	4.4	1.4– 9.1
	eggs	50	6.0	–
<i>C. glabratus</i>	adult beetles	15	285.2	206.7–357.1
	teneral beetles	20	88.9	52.3–117.6
	IIIrd instar larvae	6	39.9	21.1– 64.6
	IIInd instar larvae	3	13.4	10.9– 17.4
	Ist instar larvae	25	4.1	1.9– 6.5
	eggs	50	6.6	–
<i>C. arcensis</i>	adult beetles	26	80.7	55.5–115.6
	teneral beetles	20	27.9	22.1– 32.6
	IIIrd instar larvae	12	19.1	7.7– 37.6
	IIInd instar larvae	3	4.2	3.8– 4.9
	Ist instar larvae	2	2.0	1.6– 2.4
	eggs	50	2.5	–

Nevertheless, there exists a positive correlation between dry body weights and head widths calculated for the entire material of *C. nemoralis* larvae as well as for *C. glabratus* larvae (Fig. 2): correlation coefficients equal +0.861, $P > 0.05$ (*C. nemoralis*) and +0.866, $P > 0.05$ (*C. glabratus*). Because of a small number of the *C. arcensis* larvae, the coefficient was not examined.

Let us take into consideration: (a) mean dry weight of egg – data quoted after Grüm (1973a) – (b) mean dry body weights of the Ist, the IIInd and the IIIrd instar larvae, and (c) mean dry body weight of teneral beetles and of adult ones – data quoted after Grüm (1973b). These allow us to conclude that 14–24% of dry body weight of an adult beetle is gained during the larval development (Tab. III).

To compare the rate of dry body weight increase of larvae to that of newly hatched beetles, the mean rate of the increase has been defined for larvae, calculating the difference between mean dry body weight of the IIIrd and the Ist instar larvae divided by the product of mean dry body weight of the Ist instar and the time-lapse between the emergences of the Ist and the IIIrd instar. This time-lapse estimated previously (Grüm 1975) is equal to about 28 days in the case of *C. nemoralis* and *C. arcensis*, but about 210 days in the case of *C. glabratus*. Thus the mean rate of dry body weight increase of *C. glabratus* larvae (0.039) is much slower than that of *C. nemoralis* (0.203) of *C. arcensis* (0.305).

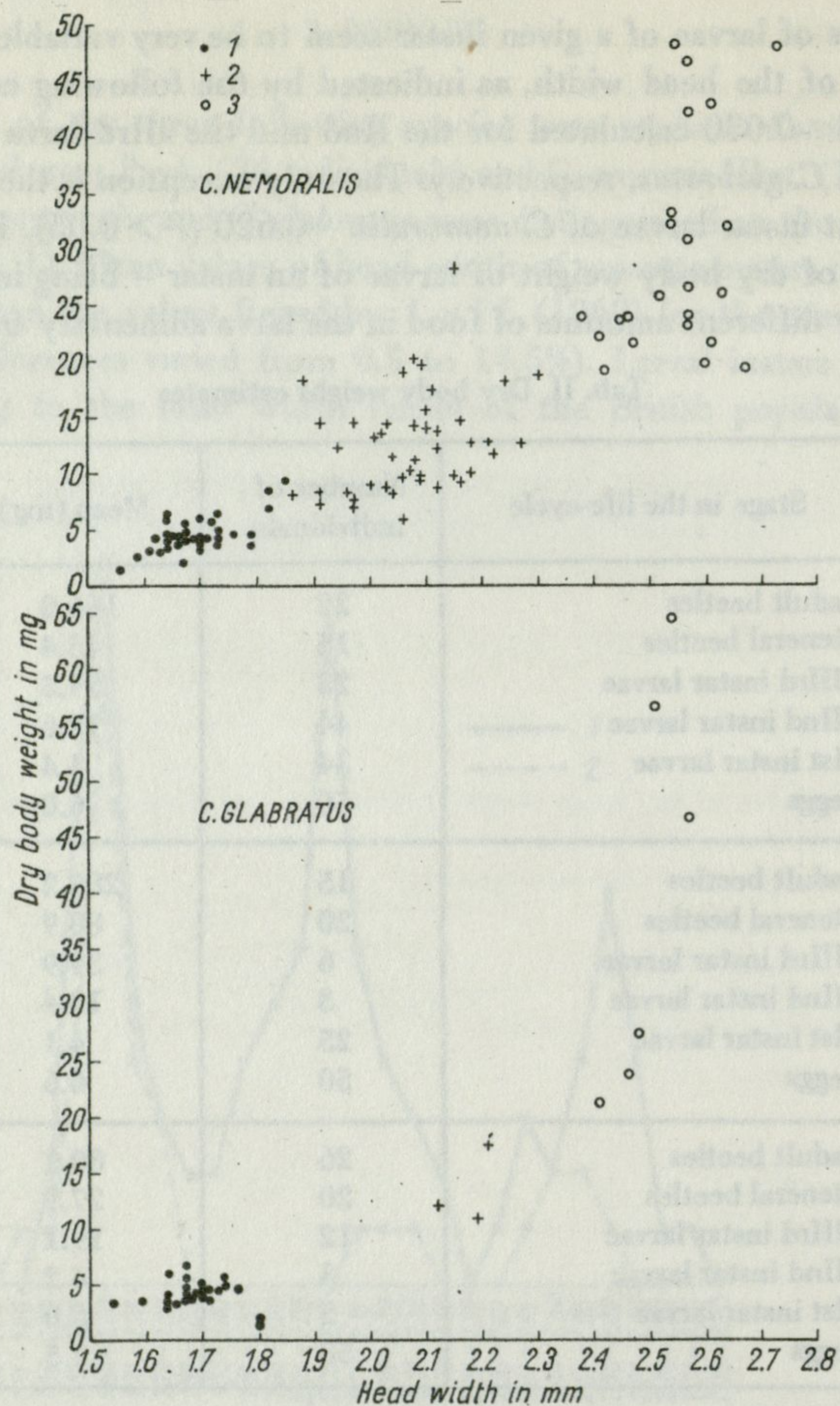


Fig. 2. Relation between dry body weight and head width

1 — Ist instar, 2 — IIInd instar, 3 — IIIrd instar

Tab. III. Percentage of dry body weight of adult beetles

Larval instar	Species		
	<i>C. nemoralis</i>	<i>C. glabratus</i>	<i>C. arcensis</i>
IIIrd	17.8	14.0	23.7
IIInd	7.6	4.7	5.2
Ist	2.6	1.4	2.5

The rate of dry body weight increase of teneral beetles is calculated according to the same principle, however, the minimal body weight of teneral beetle is substituted for the mean dry body weight. The reason is, that the mean value does not closely correspond to the weight of newly hatched beetles, because they need a few days to be captured in pitfalls, and can rapidly gain weight in the mean time. It is assumed, that the period of rapid gaining weight by newly

hatched beetles lasts about 17 days (Grüm 1973b). Thus, the calculated values of rate of dry body weight increase of teneral beetles show that the rate is the highest in the case of *C. glabratus* (0.261), and the lowest in the case of *C. arcensis* (0.156). *C. nemoralis* occupies the mid position (0.206). These results make an impression of a negative correlation between the rates of gaining weight by larvae and teneral beetles, even though the range of the larval and the teneral beetle rate seems to be similar.

3. CONCLUSIONS

The results obtained allow us to conclude the following:

1. During larval development about 14–24% of dry body weight of the adult beetle is gained.
2. The rate of dry body weight increase of larvae is comparable to that of teneral beetles, i.e., the rates are of similar range.
3. Slow rate of gaining weight by larvae seems to be correlated with rapid rate of teneral beetles of the same species.

4. SUMMARY

Growth rate of larvae of *Carabus nemoralis* Müll., *C. glabratus* Payk. and *C. arcensis* Hbst. is determined. The larval instars were distinguished on the grounds of the head width distribution (Fig. 1), or on the basis of comparison to the literature data. The larval rates of gaining weight (0.039–0.305) are of similar range to the rates of gaining weight by the teneral beetles of those species (0.156–0.261). During larval development about 14–24% of dry body weight of the adult beetle is gained (Tab. III).

5. POLISH SUMMARY (STRESZCZENIE)

Zbadano tempo przyrostu suchej masy ciała larw *Carabus nemoralis* Müll., *C. glabratus* Payk. i *C. arcensis* Hbst. Poszczególne stadia larwalne wyróżniono na podstawie analizy rozkładu liczby larw o danej szerokości głowy (fig. 1) lub porównania z danymi z literatury. Tempo wzrostu ciężaru ciała larw osiąga wartości (od 0.039 do 0.305) zbliżone do tempa przyrostu ciężaru ciała imagines podczas pierwszych 2–3 tygodni ich życia (od 0.156 do 0.261). Podczas rozwoju larwalnego osiągnięte jest 14–24% ciężaru ciała w pełni wyrosniętych imagines (tab. III).

6. REFERENCES

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