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Growth rules applied to the stage identification of nymphal instars of some mallophagan species (Phthiraptera)[1])

By

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With 3 figures and 1 table in the text

Abstract

DYAR's and PRZIBRAM-MEGUSAR's rules were used to check the growth progression of the following biting lice (Mallophaga): *Amyrsidea megalosoma* and *Uchida phasiani* (Amblycera: Menoponoidea), *Goniocotes chrysocephalus* and *Zlotorzyckella colchici* (Ischnocera: Goniodidae), *Lipeurus maculosus maculosus* and *Reticulipeurus mesopelios colchicus* (Ischnocera: Lipeuridae) and *Lagopoecus colchicus* (Ischnocera: Degeriellidae) — the parasites of pheasants (*Phasianus colchicus* L.). It was shown that the dimensions of the head and body, particularly the head width, as the most suitable measurements, follows a regular geometrical progression. The calculated values according to DYAR's rule approximate very closely to the observed measurements in all examined species. In the case of *A. megalosoma*, *G. chrysocephalus* and *L. colchicus* — they are identical. PRZIBRAM-MEGUSAR's rule revealed one latent division in the head width as well as in body of *Z. colchici*. In the case of *R. m. colchicus* only the measurements of body indicate the extra division.

Introduction

Post-embryonal development of insects is characterized by the growth of larvae. It is discontinued in the mature stage. In many insects the amount of growth achieved after each molt is regulated in accordance with certain empirical laws.

DYAR (1890) first reported that head width in the successive larval instars of Lepidoptera follows a regular geometrical progression. This rule can also be applied for calculating the actual number of molts of lepidopterous larvae.

PRZIBRAM and MEGUSAR (1912), cited by ANSARI (1954) established that in *Sphodromantis* (Orthoptera) the weight is doubled in each instar and all linear dimensions increase at each ecdysis by a constant equal to $\sqrt[3]{2} = 1.26$. Next BODENHEIMER (1933) cited also by ANSARI (1954), amplified certain important interpretations. He has shown that in some insects the rate of increase exceeds the standard coefficient because the cell division may could have occurred more that once in the same stage. He has called these extra divisions as "Latent divisions" and presented a modified definition of the PRZIBRAM-MEGUSAR's principle, namely — insect growth follows a progressive rule factor of $\sqrt[3]{2} = 1.26$ or n $\times$ 1.26 for linear dimensions.

[1]) Nach einem auf dem XIII. Berliner parasitologischen Kolloquium am 10. Oktober 1986 gehaltenen Vortrag.

It has been found that DYAR's rule as well as PRZIBRAM-MEGUSAR's principle in its modified BODENHEIMER's version apply to various other orders of Insecta: Collembola, Hymenoptera and Hemiptera. However they were of no practical value for others (f.e. *Lymantria*, *Locusta*). Their applicability is doubtful for those insects where the increase in weight at each molt is very big. In Muscidae and other flies where the larvae grow in size, but the cells do not divide after the embryonic period these rules had to be abandoned.

The nymphs of biting lice leave the eggs in a relatively advanced condition of morphological development. There are three nymphal instars. In general structure and body form they prefigure the adults. The differences are in size, weak pigmentation and different proportion of the body as well as chaetotaxy. ANSARI (1954, 1955) and ARORA et CHOPRA (1959) confirmed the applicability of these laws to some species of the biting lice parasitizing the domestic fowl (*Gallus gallus* dom.). The growth progression of *Pseudomenopon rowanae* and *Eulaemobothrion cubense* were studied by KÉLER (1952) and EICHLER (1959) respectively.

The present study was undertaken in order to check the validity of DYAR's and PRZIBRAM-MEGUSAR's principle to the nymphal instars of biting lice infesting the pheasant (*Phasianus colchicus* L.).

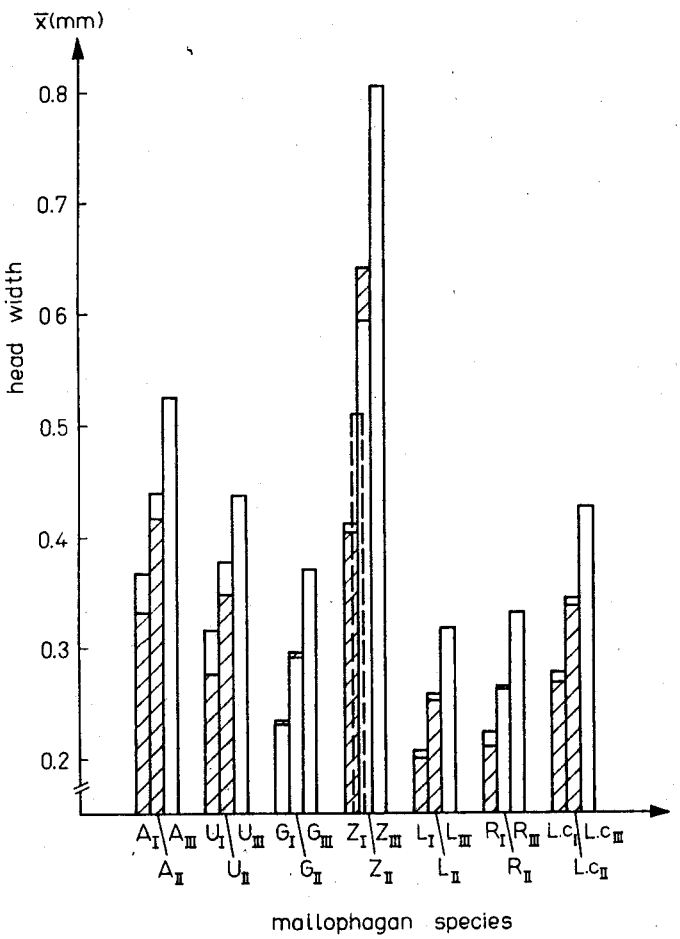

Figure 1
The observed and calculated (according to PRZIBRAM-MEGUSAR's rule) head widths of mallophagan nymphs. The measurement of head width of III instar nymphs was divided by 1.26 until a value very near the observed head width of I instar nymph was obtained. Here and in the next figures the full systematic names of the biting lice are limited to initials of genera; Roman letters mean I, II and III nymphal instars; marked rectangulars are the calculated values and broken lines indicate "Latent divisions".

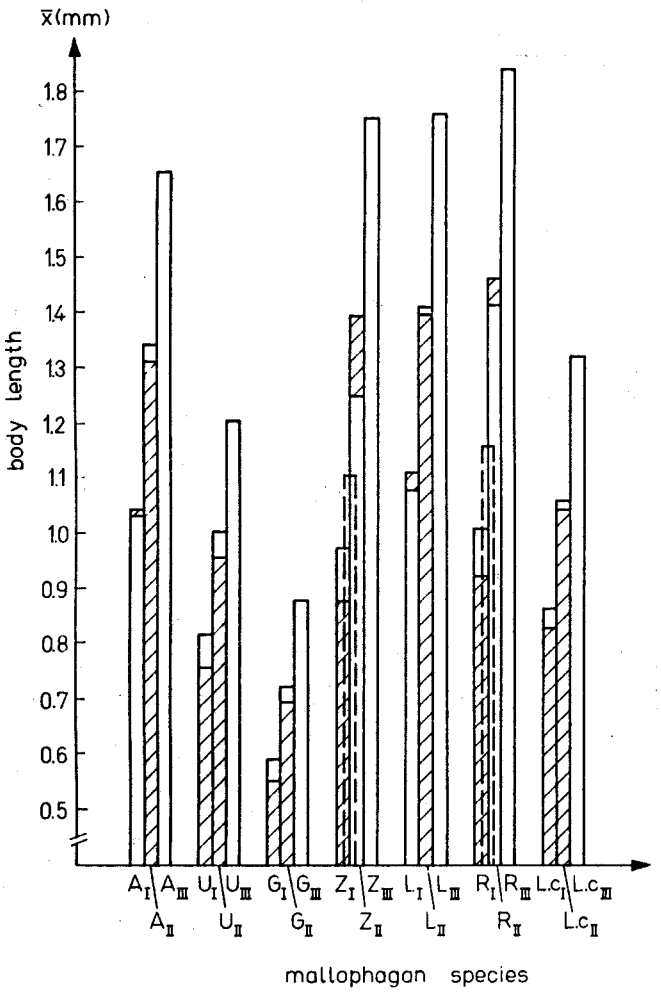

Figure 2
The observed and calculated (according to PRZIBRAM-MEGUSAR'S rule) body lenghts of mallophagan nymphs.

Results and discussion

The results of applying DYAR's rule to the head width in nymphal instars of amblyceran species: *Amyrsidea megalosoma* and *Uchida phasiani* (Menoponoidea) as well as ischnoceran: *Goniocotes chrysocephalus* and *Zlotorzyckella colchici* (Goniodidae), *Lipeurus maculosus maculosus* and *Reticulipeurus mesopelios colchicus* (Lipeuridae) and *Lagopoecus colchicus* (Degeeriellidae) — are presented in Table 1.

The observed and calculated on the basis of growth coefficient values of the head width are identical for three species: *A. megalosoma*, *G. chrysocephalus* and *L. colchicus*. In the case of *L. m. maculosus* the calculated values are close to actual measurements. The difference, stated as percentage of observed width is below 1. For the remaining species it does not exceed 4%. The growth coefficient reaches the highest value (r = 1.402) for *Z. colchici* and the smallest one (r = 1.180) for *U. phasiani*.

The similar ratios for increase in the head-width of biting lice infesting the domestic fowl (*Gallus gallus dom.*) were reported by ANSARI (1955) and ARORA et CHOPRA (1959). The growth coefficient for *Lipeurus caponis*, *Cuclotogaster heterographa*, *Goniocotes pavonis*, *Brueelia atharae*, *Quadraceps testudinarius*, *Laemobothrion titan* and *Lipeurus tropicalis* — were from 1.09 to 1.34.

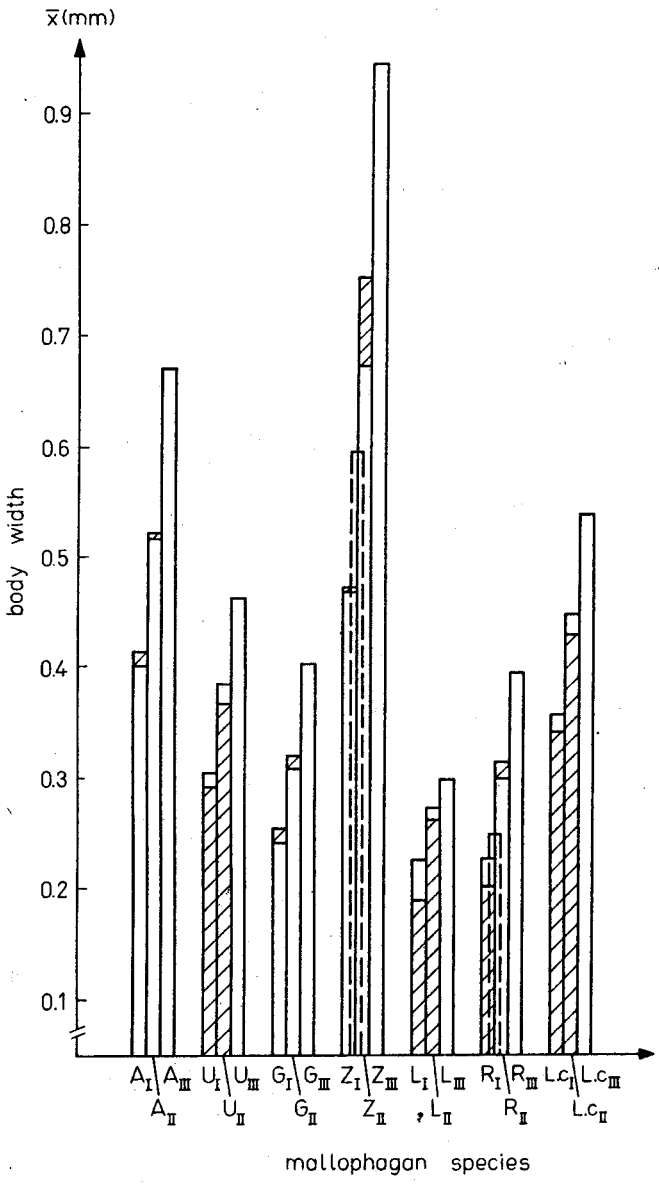

Figure 3
The observed and calculared (according to PRZIBRAM-MEGUSAR's rule) body widths of mallophagan nymphs.

In the present study the head-width calculated according to PRZIBRAM-MEGUSAR's rule is almost identical with that observed in *G. chrysocephalus* only (Fig. 1). Similarly, the small differences (1.8—3.3%) were revealed among *L. m. maculosus* and *L. colchicus*. However, for the remaining species the dissimilarity between observed and estimated arithmetric means was higher. In the case of *Z. colchici* the data indicate for the one latent division between I and II stage of nymphs.

However, the comparison with the values estimated by the DYAR's rule (Tab. 1) showed that these figures at all events were not fairly close as previous ones.

On the other hand, the body length and width calculated also with the help of PRZIBRAM-MEGUSAR's rule correspond very closely to the actual measurements in *A. megalosoma* and *U. phasiani* (Amblycera: Menoponoidea) as well as two ischnoceran species: *G. chrysocephalus* und *L. colchicus*. In turn, there is probably one latent division between I and II nymphal instars of *Z. colchici* and *R. m. colchicus* (Fig. 2 and 3).

The observed and calculated (according to Dyar's rule) head — width in the following nymphal instars (N_{I-III}) of Mallophaga

Species	Number of measured nymphal instars	Head — width (mm) observed min. — max. ($\bar{x}$)	Head — width (mm) calculated	Growth coefficient[x] (r)	Difference between calculated and observed widths expressed as percentage of observed width
1. *Amyrsidae megalosoma*	I = 35	0,32—0,40 (0,366)	—		—
	II = 35	0,38—0,47 (0,438)	0,438	1,197	0,0
	III = 45	0,47—0,57 (0,524)	0,524		0,0
2. *Uchida phasiani*	I = 16	0,29—0,35 (0,314)	—		—
	II = 26	0,35—0,39 (0,376)	0,371	1,180	—1,3
	III = 36	0,40—0,46 (0,437)	0,444		1,6
3. *Goniocotes chrysocephalus*	I = 1	0,23	—		—
	II = 15	0,27—0,31 (0,291)	0,291	1,267	0,0
	III = 79	0,30—0,40 (0,369)	0,369		0,0
4. *Zlotorzyckella colchici*	I = 45	0,39—0,45 (0,410)	—		—
	II = 45	0,53—0,63 (0,592)	0,575	1,402	—2,9
	III = 55	0,71—0,86 (0,805)	0,830		3,1
5. *Lipeurus maculosus maculosus*	I = 13	0,19—0,23 (0,205)	—		—
	II = 13	0,24—0,30 (0,256)	0,255	1,242	—0,4
	III = 21	0,28—0,36 (0,316)	0,318		0,6
6. *Reticulipeurus mesopelios colchicus*	I = 21	0,20—0,25 (0,222)	—		—
	II = 25	0,23—0,29 (0,261)	0,271	1,220	3,8
	III = 28	0,28—0,37 (0,330)	0,318		—3,6
7. *Lagopoecus colchicus*	I = 14	0,25—0,30 (0,276)	—		—
	II = 17	0,31—0,37 (0,342)	0,342	1,239	0,0
	III = 28	0,38—0,46 (0,424)	0,424		0,0

[x]growth coefficient (r) was worked out by dividing the average observed width in each instar by that of previous instar and an average of all ratios was then calculated

These results conform ANSARI's (1955) and ARORA et CHOPRA's (1959) opinion that may occur one latent division between I and II instars among Ischnocera while none at all in Amblycera species.

Conclusions

The results presented here in tables as well as in figures (see also LONC and MODRZEJEWSKA, 1986) indicate that the dimensions of the head and body of Mallophaga are good diagnostic characters of nymphs.

Particularly, the head width, as the best discriminator, can be safely used for the indication of the instar and for their separation within and between closely related species.

PRZIBRAM-MEGUSAR's rule as modified by BODENHEIMER when applied to the biting lice may predict the chance of additional developmental stage. A latent division in the head width as well as in the body length and width between first and second instars of *Zlotorzyckella colchici* was found. In the case of *Reticulipeurus mesopelios colchicus* only the measurements of body indicate that extra division.

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References

ANSARI, A. R. (1954): Pre-imaginal instars of Mallophaga and application of some growth principles. — Pakistan Journal of Science **6**: 155—161.

— (1955): Synoptic table for the determination of Mallophaga infesting the domestic fowl (*Gallus gallus dom*). — Indian Journal of Entomology, **17**: 245—270.

ARORA, G. L. and N. P. CHOPRA, (1959): Observations on the life-history of *Lipeurus tropicalis* PETERS (Mallophaga: Ischnocera). — Research Bulletin (N. S.) of the Panjab University, **10**: 179—187.

DYAR, H. G. (1890): The number of molts of lepidopterous larvae. - Psyche, **5**: 420 -422.

EICHLER, Wd. (1959): Die Larvenstadien der Mallophagen. I. *Eulaemobothrion cubense* (KELLOGG & FERRIS). — Wissenschaftliche Zeitschrift der MARTIN-LUTHER-Universität Halle—Wittenberg, **8**: 543—547.

KÉLER, S. v. (1952): Über die Wachstums-Progression bei *Pseudomenopon rowanae* KÉLER. (Mallophaga). — Beiträge zur Entomologie, **2**: 113—119.

LONC, E. and M. MODRZEJEWSKA, (1986): An attempt to identification of nymphal instars of biting lice (Mallophaga) using discriminant function. — Polskie Pismo Entomologiczne, **56**: 153—162.

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