

A Numerical Study on the Growth Factors in *Anoplocnemis
dallasi* K. (Hem., Coreidae)

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장수허리 노린재(*Anoplocnemis dallasi* K.)에 있어서
성장인자에 관한 數理生物學的 研究

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摘 要

장수허리 노린재의 後胚子 成長期에 있어서 體長, 前胸背板의 幅, 觸角, 口吻, 前脚, 中脚, 後脚을 대상으로 第1齡 幼虫부터 成虫에 이르기까지의 길이를 測定하여 Harmann의 因子分析法을 應用하여 成長因子를 分析한 結果 다음과 같은 結論을 얻었다. 1. 7個 體量은 4개의 成長因子가 區別된다. 2. 第1因子는 一般因子로서 成長促進因子였고, 나머지 第2, 第3, 第4의 3個因子는 대개 群因子로서 作用하였다. 3. 4種의 因子를 綜合해보면 7個의 體量은 成長影響을 달리하는 體長·中脚·後脚의 第1群, 前脚의 第2群과 前胸背板의 幅·觸角·口吻의 第3群으로 區別할 수 있었으나 第2群은 第1群에 近似하였다. 4. 中脚의 共通度가 가장 크고, 體長의 共通度는 가장 낮다. 반던 獨白度는 中脚의 것이 가장 작고, 體長의 獨白度는 가장 크다. 5. 成長因子的 特長은 齡이 進전됨에 따라 증가한다. 6. 若齡幼虫에 있어서 各體量間相關은 작아지는 경향을 보이고, 老齡幼虫에 있어서의 相關은 커지는 경향이였다.

INTRODUCTION

The processes of growth and development begin with the first cleavage of the egg and end when the individual has completed its life cycle. Growth in insects

is influenced by inherited differences in the individual's own growth impulse and by uncontrolled environmental factors. Each insect group shows particular differences, but some general patterns and some factors are followed by all insects to a greater or lesser extent.

We may assume that the factors affecting growth will be numerous. However, we can distinguish the embodiment of some factors which are grading and homogenizing a large number of supposed factors. These act to promote or to check the growth of each part of the body.

The ecdysis by which insects grow and differentiate is regarded only as the changing point in the action of the growing factors. So the lengths and weights of a certain variable in a fixed period are regarded as the synthetic expression of all those factors which acted in the previous stages. Therefore, for the factors affecting growth, there are numerous elements of which characters vary with the stages, the kinds of variables, and the activities and directions of the influences. The adult thus ultimately being formed by a predetermined process, which is modified environmentally throughout the developmental stages.

The factors are of two types: The common factors are those which are involved in more than one variable in the set, the unique factors are those which appear exclusively in the description of a particular variable. Two instances of the common factors arise; the general factors present in all variables, and the group factors present in more than one, but not in all variables.

Until recently some entomologists used univariate statistical method to describe the shape change which insects undergo during growth. Little attention, by the way, was given to the application of multivariate statistical techniques which might lead to a better understanding of the factors influencing the growth pattern of insects. Rao and Garg (1967) adopted the Centroid Method of Harman's factor analysis in the study on the growth pattern of the antennae of *Gerris flaviorum*. Lee and Park (1974) applied the Averoid Solution in the study of growth factors of *Gerris elongatus* and investigated the difference between sexes.

The present authors also applied a factor analysis method derived from Harman's method on the growth of *Anoplocnemis dallasi* K. and investigated the affecting extent and the relation between factors and development of the instars. The authors chose the lengths of seven variables in each individual for instars. The characteristic values used in this work were standardized from the original data.

MATERIALS AND TECHNIQUES

Materials: The authors collected specimens of the post embryonic developmental

stages of *A. dallasi* which inhabit the campus of Kyungpook University, in July to August, 1970. Perfect specimens being used were selected as fifty individuals of the first instar and seventy individuals of the second instar to the adult respectively. The larvae were preserved in alcohol, but the adult specimens were dried. All measurements of the seven parts of the body were made under the stereoscopic microscope with a linear micrometer, and converted to *mm*. The seven variables—body length, width of pronotum, length of the antenna of the rostrum, of the fore leg, of the middle leg and of the hind leg—are treated in the present paper. For measurements, the appendages were removed from the body. The lengths of the legs are treated as the summed values of coxa, trochanter, femur and tibia which were measured respectively. The lengths of tarsi were excepted. The lengths of antenna and rostrum are also the sum of the values obtained for the four segments. Paired aspects were measured on one side only.

Computing techniques: The coefficients of correlation amongst the seven variables were computed from the standardized values. The coefficients form the correlation matrix from which the factor loadings were extracted by the factor analysis. The present authors insert zero in the diagonal elements of the symmetrical matrix. If over half columns or rows of the matrix contain negative coefficients, it is necessary to change the signs. When the number of the variables with the negative sign equals that with the positive one, it is necessary to change the signs only in case of the negative sum of the column or row. It is unnecessary to change the signs in the case of the positive sum. In case of the former, when the numbers of the negative sum is over two sets, the authors change firstly the signs of the set of which the final numbers of negative entries are minimum. The sum of the complete rows of the matrix is obtained using the formula $S_i = \sum_{k=1}^n r_{ik} (n=7)$.

The grand total was calculated using the formula $T = \sum_{i=1}^n S_i (n=7)$ for all the entries in the matrix. Then the coefficients of the first factor loading were computed by means of the formula $K_{1i} = S_i \sqrt{\frac{N}{T(N-1)}}$ ($i=1, 2, 3, 4, 5, 6, 7$; N =Nos. of variables). Next if the signs were changed they have to be reflected. In order to obtain the first factor residual the product matrix $K_{1i} \cdot K_{1j}$ ($i, j=1, 2, 3, 4, 5, 6, 7$; if $i=j$, then $K_{1i} \cdot K_{1j}=0$) was calculated from the first factor loadings. Next the first factor residual, the correlation matrix for extracting the second factor loading is obtained by subtracting the values in the product matrix from the corresponding entries in the original correlation matrix. Then the second factor loadings are calculated from the values in the first factor residual by the same procedure as for the first factor loadings. This procedure was repeated until sufficient

factors were extracted, to account for total communality.

The sum of the squares of all the common factors in the set is the communality of a variable. This may be obtained simply by using the formula $h_i^2 = K_{1i}^2 + K_{2i}^2 + K_{3i}^2 + K_{4i}^2$ ($i=1, 2, 3, 4, 5, 6, 7$). The contribution of the unique factor and the error equals the uniqueness $u_i^2 = 1 - h_i^2$ ($i=1, 2, 3, 4, 5, 6, 7$).

RESULTS

Table 1 gives the measurements of seven aspects for the six developmental stages in *A. dallasi*. Applying the factor analysis to the standardized values of these measurements, we obtained the results given in Tables 2 to 19 for the coefficient of correlation, the four factor loadings, the communality and the uniqueness.

Table 1. The lengths of the seven aspects for instar in micron (Mean \pm Standard deviation).

	1st	2nd	3rd	4th	5th	AD
B	3673 \pm 256	4748 \pm 197	7947 \pm 754	10837 \pm 1299	16402 \pm 1658	22018 \pm 880
W	1010 \pm 65	1284 \pm 35	2162 \pm 130	3650 \pm 195	6018 \pm 423	7414 \pm 489
AT	4384 \pm 118	6510 \pm 144	8393 \pm 315	10222 \pm 517	12664 \pm 698	13695 \pm 593
R	1591 \pm 64	2244 \pm 47	2844 \pm 96	3487 \pm 76	4294 \pm 141	4806 \pm 126
F	3662 \pm 97	5320 \pm 109	7120 \pm 281	9304 \pm 464	12373 \pm 1164	13792 \pm 592
M	3764 \pm 117	5394 \pm 115	7346 \pm 317	9714 \pm 500	13317 \pm 689	15661 \pm 794
H	4456 \pm 106	6580 \pm 81	9112 \pm 388	12204 \pm 580	16887 \pm 745	20197 \pm 874

B : Body length	1st : First instar larva	M : Midleg
W : Width of pronotum	2nd : Second instar larva	H : Hindleg
AT : Antenna	3rd : Third instar larva	AD : Adult
R : Rostrum	4th : Fourth instar larva	
F : Foreleg	5th : Fifth instar larva	

Employing the rectangular coordinate system which denotes the w -axis by the first factor loading K_1 , the x -axis by the second factor loading K_2 , the y -axis by the third factor loading K_3 and the z -axis by the fourth factor loading K_4 for the geometric interpretation of the four factors, the authors projected the points for these seven aspects on the plane of the four common factors. The clusters of positive plotting on the axes are the geometric basis for the naming of the general factor, while the clusters of negative plotting on the axes furnish interpretation for the group factor.

The first instar larva: In the first stage, we obtained the results given in Tables 2 to 4 for the coefficient of correlation, the four factor loadings, the communality and the uniqueness.

The intercorrelations of the seven aspects are given in Table 2 as the correlation matrix. All these coefficients except the correlation of the width of pronotum with the hind leg show the positive values. The correlations of the antenna with the fore leg, the middle leg and the hind leg, of the fore leg with the middle leg and the hind leg, of the middle leg with the hind leg are very highly significant at the $P < 0.001$ level. The correlations of the body length with the antenna, the middle leg and the hind leg are significant at the $0.001 < P < 0.01$ level. The correlation of the body length with the fore leg is in the significant level $0.01 < P < 0.05$. The correlation of the rostrum with the fore leg is in the significant level $0.05 < P < 0.01$. But the correlations of the body length with the width of pronotum and the rostrum, of the width of pronotum with the antenna, the rostrum, the fore leg, the middle leg and the hind leg, of the antenna with the rostrum, of the rostrum with the middle leg and the hind leg are nonsignificant.

Table 2. The correlation matrix of seven variables for the first instar larva.

Variable	B	W	AT	R	F	MH
B						
W	0.0300					
AT	0.4316	0.1703				
R	0.1663	0.1026	0.0382			
F	0.3188	0.0341	0.7372	0.2707		
M	0.3571	0.1448	0.8847	0.0034	0.8512	
H	0.3892	-0.0534	0.8155	0.1050	0.8530	0.9008

It is considered that the first factor loadings K_1 , which show all the positive coefficients as shown in Table 3, might act to promote growth of all the variables as the general factor. The middle leg has the highest value, and the antenna, the fore leg, the hind leg, the body length, the rostrum and the width of pronotum follow in that order. It is considered that the second factor loadings K_2 , which show the negative form for the body length, the width of pronotum and the rostrum, might act to check growth as the group factor. However, we read the positive values in K_2 of the other aspects, i.e., the antenna, the fore leg, the middle leg and the hind leg. The rostrum has the lowest value, and the width of pronotum, the body length, the antenna, the fore leg, the middle leg and the hind leg follow in that order. It is considered that the third factor loadings K_3 might act to promote growth of all the aspects as the general factor like the first factor loadings K_1 . The rostrum has the highest value, and the antenna, the fore leg, the middle leg, the hind leg, the width of pronotum and the body length follow in that order. It is considered that the fourth factor loadings K_4 which show the negative form for the width of pronotum, the antenna

and the middle leg, might act to check growth as the group factor. Whereas, we read the positive values in K_4 of the other four aspects, i.e., body length, rostrum, fore leg and hind leg. The rostrum has the highest value, and the hind leg, the fore leg, the body length, the middle leg, the antenna and the width of pronotum follow in that order.

Table 3. The factor loadings of seven aspects for the first instar larva.

Variable	Factor loading	I	II	III	IV
B		0.4689	-0.1038	0.0515	0.0179
W		0.1186	-0.1105	0.0545	-0.2743
AT		0.8524	0.1912	0.1632	-0.2035
R		0.1900	-0.2631	0.2518	0.3104
F		0.8503	0.2100	0.1513	0.1721
M		0.8703	0.4072	0.1438	-0.2016
H		0.8351	0.4308	0.0958	0.1991

The diagram for these seven variables on the planes of the four factors is presented in Figs. 1 to 6. On the plane of the two factors K_1-K_2 , as indicated in Fig. 1, the antenna, the fore leg, the middle leg and the hind leg are projected in the first quadrant, while the body length, the width of pronotum and the rostrum are projected in the fourth quadrant. On the plane of the two factors K_1-K_3 , as indicated in Fig. 2, all the seven aspects are projected in the fourth quadrant. On the plane of the two factors K_1-K_4 , as indicated in Fig. 3, the body length, the rostrum, the fore leg and the hind leg are projected in the first quadrant, while the width of pronotum, the antenna and the middle leg in the fourth quadrant. On the plane of the K_2-K_3 , as indicated in Fig. 4, the antenna, the fore leg, the middle leg and the hind leg are distributed in the first quadrant, while the body length, the width of pronotum and the rostrum in the second quadrant. On the plane of the K_2-K_4 , as indicated in Fig. 5, all the seven aspects showed wide dispersion plotted in all the four quadrants such as the fore and hind legs are projected in the first quadrant, the body length and rostrum in the second quadrant, the width of pronotum in the third quadrant, the antenna and middle leg in the fourth quadrant. Finally, on the plane of the factors K_3-K_4 , as indicated in Fig. 6, the body length, the rostrum, the fore leg and the hind leg are projected in the first quadrant, while the width of pronotum, the antenna and the middle leg in the fourth quadrant.

The communality of the middle leg is the greatest as indicated in Table 4, and the hind leg, the antenna, the fore leg, the rostrum, the body length and the width of pronotum follow in the written order. Conversely, the width of pronotum shows the greatest uniqueness, and the body length, the rostrum, the

Table 4. The communality and uniqueness of seven variables for the first instar larva.

Variable	Communality	Uniqueness
B	0.2336	0.7664
W	0.1044	0.8956
AT	0.8311	0.1689
R	0.2650	0.7350
F	0.8196	0.1804
M	0.9845	0.0155
H	0.9317	0.0683

fore leg, the antenna, the hind leg and the middle leg follow in that order.

The second instar larva: In the second stage, we obtained the result given in Tables 5 to 7 for the coefficient of correlation, the four factor loadings, the communality and the uniqueness.

The intercorrelations of the seven body parts are given in Table 5 as the correlation matrix. All these coefficients except the correlation of the body length with the width of pronotum show the positive values. The correlations of the antenna with the fore leg, middle leg and hind leg, of the rostrum with the hind leg, of the fore leg with the middle and hind legs, and of the middle leg with the hind leg are very highly significant at the $P < 0.001$ level. The correlations of the rostrum with the body length and the middle leg are significant at the $P > 0.01$ level. The correlations of the body length with the middle and hind legs, and of the fore leg with the width of pronotum and the rostrum are significant at the $P < 0.05$ level. The correlation of the antenna with the rostrum is significant at the $P < 0.1$ level. But the correlations of the body length with the width of pronotum, the antenna and the fore leg, and of the width of pronotum with the antenna, the rostrum, the middle leg and the hind leg are insignificant.

Table 5. The correlation matrix of seven variables for the second instar larva.

Variable	B	W	AT	R	F	M	H
B							
W	-0.0149						
AT	0.0703	0.0966					
R	0.3638	0.1164	0.2117				
F	0.0660	0.2335	0.4725	0.2536			
M	0.2321	0.1554	0.3944	0.3705	0.6940		
H	0.2566	0.1226	0.4683	0.4089	0.6213	0.7254	

It is considered that the first factor loadings K_1 , like the first instar larva, which show all the positive coefficients as shown in Table 6, might act to

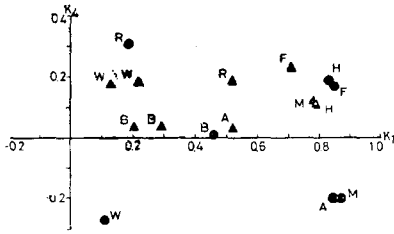


Fig. 1. The distribution of seven parts of the body on the two factors K₁-K₂ plane for the first and second instar larvae. (Abbreviations are the same as in table 1).

- : The first instar larva
- K₁ : First factor
- ▲ : The second instar larva
- K₂ : Second factor

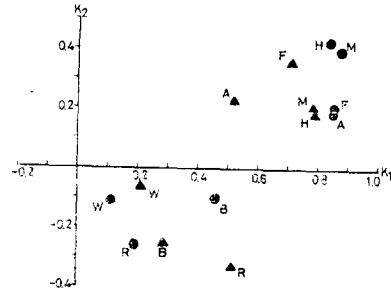


Fig. 2. The distribution of seven parts of the body on the two factors K₁-K₂ plane for the first and second instar larvae. (Abbreviations are the same as in table 1).

- : The first instar larva
- K₁ : First factor
- ▲ : The Second instar larva
- K₃ : Third factor

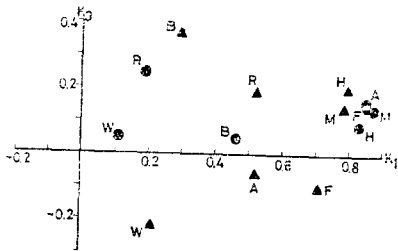


Fig. 3. The Distribution of seven parts of the body on the two factors K₁-K₃ plane for the first and second instar larvae. (Abbreviations are the same as in table 1).

- : The first instar larva
- K₁ : First factor
- ▲ : The second instar larva
- K₃ : Fourth factor

length, the width of pronotum and the rostrum. The fore leg has the highest value, and the antenna, the middle leg, the hind leg, the width of pronotum, the body length and the rostrum follow in that order. It is considered that the third factor loading K₃ was also the group factor like the second factor. It might act to promote growth for the body length, the rostrum, the middle leg and the hind leg, while to check growth for the width of pronotum, the antenna and the fore leg. The body length has the highest value, and the hind leg, the rostrum, the middle leg, the antenna, the fore leg and the width of pronotum follow in that order. It is considered that the fourth factor loading K₄ was the general

promote growth of all the body parts as the general factor. The hind leg has the highest value, and the middle leg, the fore leg, the rostrum, the antenna, the body length and the width of pronotum follow in the written order. It is considered that the second factor loadings K₂ which show positive form for the antenna, the fore leg, the middle leg and the hind leg, might act to promote growth as the group factor. However, we read the negative values which might act to check growth as the group factor for K₂ of the body

Table 6. The factor loadings of seven variables for the second instar larva.

Variable	factor loading	I	II	III	IV
B		0.2958	-0.2541	0.3757	0.0357
W		0.2155	-0.0601	-0.2205	0.1880
At		0.5206	0.2332	-0.0663	0.0345
R		0.5240	-0.3318	0.1901	0.1956
F		0.7111	0.3669	-0.1070	0.2327
M		0.7813	0.2162	0.1410	0.1225
H		0.7908	0.1928	0.2071	0.1193

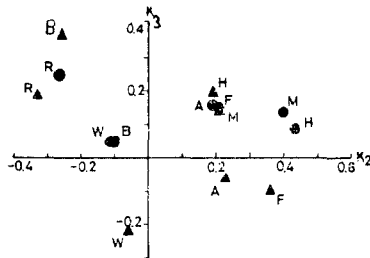


Fig. 4. The distribution of seven parts of the body on the two factors K_2 — K_3 plane for the first and second instar larvae. (Abbreviations are the same as in table 1).

- : The first instar larva
- K_2 : Second factor
- ▲ : The second instar larva
- K_3 : Third factor

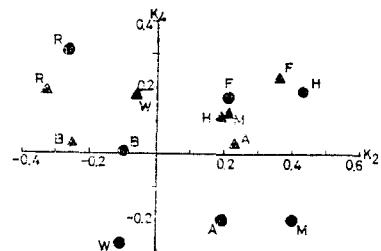


Fig. 5. The distribution of seven parts of the body on the two factors K_2 — K_4 plane for the first and second instar larvae. (Abbreviations are the same as in table 1).

- : The first instar larva
- K_2 : second factor
- ▲ : The second instar larva
- K_4 : Fourth factor

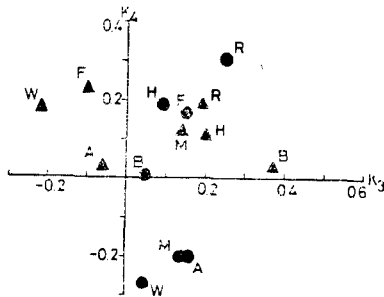


Fig. 6. The distribution of seven parts of the body on the two factors K_3 — K_4 plane for the first and second instar larvae. (Abbreviations are the same as in table 1).

- : The first instar larva
- K_3 : Third factor
- ▲ : The second instar larva
- K_4 : Fourth factor

factor. It might act to promote growth of all the aspects like the first factor. The fore leg has the highest value, and the rostrum, the width of pronotum, the middle leg, the hind leg, the body length and the antenna follow in that order.

The diagram for these seven aspects on the planes of the four factors is presented in Figs. 1 to 6. On the plane of the two factors K_1 — K_2 , as indicated in Fig. 1, the antenna, the fore leg, the middle leg and the hind leg are projected in the first quadrant, while the body length, the width of pronotum

and the rostrum are distributed in the fourth quadrant. On the plane of the two factors K_1-K_3 , as indicated in Fig. 2, the body length, the rostrum, the middle leg and the hind leg are projected in the first quadrant, while the width of pronotum, the antenna and the fore leg in the fourth quadrant. On the plane of the factors K_1-K_4 , as indicated in Fig. 3, all the seven body parts are distributed in the first quadrant. On the plane of the factors K_2-K_3 , as indicated in Fig. 4, all the seven aspects showed wide dispersion plotting all the four quadrants such as the middle and hind legs are projected in the first quadrant, the body length and the rostrum in the second, the width of pronotum in the third, the antenna and the fore leg in the fourth. On the plane of the factors K_2-K_4 , as indicated in Fig. 5, the antenna, the fore leg, the middle leg and the hind leg are distributed in the first quadrant, while the body length, the width of pronotum and the rostrum in the second quadrant. Finally, on the plane of the K_3-K_4 , as indicated in Fig. 6, the body length, the rostrum, the middle leg and the hind leg are projected in the first quadrant, whilst the width of pronotum, the antenna and the fore leg in the second quadrant.

The communality of the hind leg is the greatest as indicated in Table 7, and the fore leg, the middle leg, the rostrum, the antenna, the body length and the width of pronotum follow in that order. Conversely, the width of pronotum shows the greatest uniqueness, and the body length, the antenna, the rostrum the fore leg and the hind leg follow in that order.

The third instar larva: In the third stage, we obtained the results given in Tables 8 to 10 for the coefficient of correlation, the four factors, the communality and the uniqueness.

Table 7. The communality and uniqueness of seven variables for the second instar larva.

Variable	Communality	Uniqueness
B	0.2944	0.7056
W	0.1340	0.8660
AT	0.3309	0.6691
R	0.4590	0.5410
F	0.7058	0.2942
M	0.6920	0.3080
H	0.7196	0.2804

The intercorrelations of the seven aspects are given in Table 8 as the correlation matrix. All these coefficients show the positive values. The correlations of the body length with the antenna and the fore leg, of the width of pronotum with the antenna, the rostrum, the fore leg, the middle leg and the hind leg, of

the antenna with the rostrum, the fore leg, the middle leg and the hind leg, of the rostrum with the fore leg, the middle leg and the hind leg, of the fore leg with the middle leg and the hind leg, of the middle leg with the hind leg are very highly significant at the $P < 0.001$ level. The correlations of the body length with middle leg and the hind leg are significant at the $P < 0.01$ level. The correlation of the body length with the width of pronotum is significant at the $P < 0.05$ level. The correlation of the body length with the rostrum is nonsignificant.

Table 8. The correlation matrix of seven variables for the third instar larva.

Variable	B	W	AT	R	F	M	H
B							
W	0.2332						
AT	0.5053	0.4806					
R	0.1258	0.4329	0.6467				
F	0.3926	0.5471	0.8173	0.6541			
M	0.3382	0.5315	0.8326	0.6557	0.8553		
H	0.3511	0.5323	0.8356	0.6480	0.8520	0.9084	

It is considered that the first factor loadings K_1 like the preceding two instars, which show all the positive coefficients as shown in Table 9, might act to promote growth of all the aspects as the general factor. The hind leg has the highest value, and the middle leg, the fore leg, the antenna, the rostrum, the width of pronotum and the body length follow in that order. It is considered that the second factor loadings K_2 which show the positive form for the antenna, the rostrum, the fore leg, the middle and hind legs, might act to promote growth as the group factor. However, we read the negative values which might act to check growth for K_2 of the body length and the width of pronotum. The rostrum has the highest value, and the middle leg, the hind leg, the fore leg, the antenna, the width of pronotum and the body length follow in that order. It is considered that the third factor loading K_3 was also the group factor like the preceding second factor. It might act to promote growth for the body length, the antenna, the fore leg, the middle and hind legs, whilst to check growth for the rostrum and the width of pronotum. The body length has the highest value, and the antenna, the hind leg, the middle leg, the fore leg, the width of pronotum and the rostrum follow in that order. It is considered that the fourth factor loadings K_4 was also the group factor like the above third factor. We read the positive values regarding as the promoting growth factor for the width of pronotum, the middle and hind legs, whilst the negative values regarding as the checking growth factor for the body length, the antenna and the rostrum. The middle leg has the highest value, and the hind leg, the width of pronotum, the fore leg, the rostrum,

the body length and the hind leg follow in that order.

Table 9. The factor loadings of seven variables for the third instar larva.

Variable	Factor loading	I	II	III	IV
B		0.4258	-0.1016	0.2981	-0.0905
W		0.6033	-0.0492	-0.1162	0.0952
AT		0.9010	0.0130	0.2150	-0.2554
R		0.6921	0.2845	-0.2533	-0.0617
F		0.9011	0.1137	0.0425	0.0246
M		0.9018	0.2681	0.0875	0.1539
H		0.9030	0.2427	0.1011	0.1418

On the plane of the two factors K_1-K_2 , the antenna, the rostrum, the fore leg, the middle and hind legs are projected in the first quadrant, whilst the body length and the width of pronotum in the fourth quadrant. On the plane of the two factors K_1-K_3 , the body length, the antenna, the fore leg, the middle leg and the hind leg are projected in the first quadrant, whilst the width of pronotum, the rostrum in the fourth quadrant. On the plane of the factors K_1-K_4 the width of pronotum, the fore leg, the middle leg and the hind leg are distributed in the first quadrant, whilst the body length, the antenna and the rostrum in the fourth quadrant. On the plane of the factors K_2-K_3 , the seven aspects showed wide dispersion plotted in all the four quadrants such as the antenna, the fore leg, the middle leg and the hind leg are plotted in the first quadrant, the body length in the second, the width of pronotum in the third, the rostrum in the fourth. On the plane of the factors K_2-K_4 , it showed also wide dispersion such as the fore leg, the middle leg and the hind leg are projected in the first quadrant, the width of pronotum in the second, the body length in the third, the antenna and the rostrum in the fourth. Finally, on the plane of the factors K_3-K_4 , it showed also wide dispersion. The fore leg, the middle leg and the hind leg are plotted in the first quadrant, the width of pronotum in the second, the rostrum in the third, the body length and the antenna in the fourth.

The communality of the antenna is the greatest as indicated in Table 10, and the middle leg, the hind leg, the fore leg, the rostrum, the width of pronotum and the body length follow in that order. Conversely, the body length shows the greatest uniqueness, and the width of pronotum, the rostrum, the fore leg, the hind leg, the middle leg and the antenna follow in that order.

The fourth instar larva: In the fourth stage, we obtained the results given in Tables 11 to 13 for the coefficient of correlation, the four factors, the communality and the uniqueness.

The intercorrelations of the seven aspects are given in Table 11 as the corre-

Table 10. The communality and uniqueness of seven variables for the third instar larva.

Variable	Communality	Uniqueness
B	0.2886	0.7114
W	0.3889	0.6111
AT	0.9234	0.0766
R	0.6279	0.3721
F	0.8273	0.1727
M	0.9164	0.0836
H	0.9046	0.0954

lation matrix. All these coefficients except the correlation of the body length with the rostrum show the positive values. The correlations of the body length with the width of pronotum, the fore leg, the middle leg and the hind leg, of the width of pronotum with the antenna, the rostrum, the fore leg, the middle leg and the hind leg, of the antenna with the rostrum, the fore leg, the middle leg and the hind leg, of the rostrum with the fore leg, the middle leg and the hind leg, of the fore leg with the middle and hind legs, and of the middle leg with the hind leg are very highly significant at the $P < 0.001$ level. The correlation of the body length with the antenna is significant at the $P < 0.05$ level. The correlation of the body length with the rostrum is nonsignificant.

Table 11. The correlation matrix of seven variables for the fourth instar larva.

Variable	B	W	AT	R	F	M	H
B							
W	0.5413						
AT	0.2632	0.6076					
R	-0.0232	0.5630	0.4003				
F	0.3884	0.8149	0.7634	0.4680			
M	0.4006	0.8142	0.7540	0.4923	0.8935		
H	0.4949	0.7791	0.7310	0.4520	0.8877	0.9414	

It is considered that the first factor loadings K_1 like the preceding three instars, which show all the positive coefficients as shown in Table 12, might act to promote growth of all the aspects as the general factor. The middle leg has the highest value, and the hind leg, the fore leg, the width of pronotum, the antenna, the rostrum and the body length follow in that order. It is considered that the second factor loadings K_2 which show the positive form for the antenna, the rostrum, the fore leg, the middle leg and the hind leg, might act to promote growth as the group factor. However, we read the negative values which might act to check growth for K_2 of the body length and the width of pronotum. The

antenna has the highest value, and the middle leg, the fore leg, the rostrum, the hind leg, the width of pronotum and the body length follow in that order. It is considered that the third factor loadings K_3 was also the group factor like the third instar larva. It might act to promote growth for the body length, the antenna, the fore leg, the middle leg and the hind leg, while to check growth for the width of pronotum and the rostrum. The body length has the highest value, and the hind leg, the middle leg, the fore leg, the antenna, the width of pronotum and the rostrum follow in that order. It is considered that the fourth factor loadings K_4 was also the group factor like the preceding third instar larva. We read the positive values regarding as the promoting growth factor for the body length, the width of pronotum, the rostrum, the fore leg, the middle leg and the hind leg, while the negative values regarding as the checking growth factor for the antenna. The width of pronotum has the highest value, and the hind leg, the middle leg, the rostrum, the body length, the fore leg and the antenna follow in that order.

Table 12. The factor loadings of seven variables for the fourth instar larva.

variable	Factor loading	I	II	III	IV
B		0.4473	-0.3725	0.3019	0.1072
W		0.8924	-0.1498	-0.0711	0.3122
AT		0.7623	0.2599	0.0930	-0.0466
R		0.5095	0.1351	-0.3700	0.1321
F		0.9131	0.1519	0.0931	0.0698
M		0.9305	0.1887	0.1119	0.1547
H		0.9283	0.0784	0.2465	0.1726

On the plane of the two factors K_1-K_2 , the antenna, the rostrum, the fore leg, the middle leg and the hind leg are projected in the first quadrant, while the body length and the width of pronotum in the fourth quadrant. On the plane of the two factors K_1-K_3 , the body length, the antenna, the fore leg, the middle leg and the hind leg are projected in the first quadrant, while the width of pronotum and the rostrum in the fourth quadrant. On the plane of the two factors K_1-K_4 , the body length, the width of pronotum, the rostrum, the fore leg, the middle leg and the hind leg are projected in the first quadrant, while only the antenna in the fourth quadrant. On the plane of the factors K_2-K_3 , the antenna, the fore leg, the middle leg and the hind leg are distributed in the first quadrant, the body length in the second quadrant, the width of pronotum in the third quadrant, the rostrum in the fourth quadrant. On the plane of the factors K_2-K_4 , the rostrum, the fore leg, the middle leg, the hind leg are projected in the first quadrant, the body length and the width of pronotum in the

second quadrant, and the antenna in the fourth quadrant. On the plane of the factors K_3 – K_4 , the body length, the fore leg, the middle leg and the hind leg are plotted in the first quadrant, the width of pronotum and the rostrum in the second quadrant, and the antenna in the fourth quadrant.

Table 13. The communality and uniqueness of seven variables for the fourth instar larva.

Variable	Communality	Uniqueness
B	0.4414	0.5586
W	0.9213	0.0787
AT	0.6594	0.3406
R	0.3821	0.6179
F	0.8703	0.1297
M	0.9378	0.0622
H	0.9584	0.0416

The communality of the hind leg is the greatest as indicated in Table 13, and the middle leg, the width of pronotum, the fore leg, the antenna, the body length and the rostrum follow in that order. Conversely, the rostrum shows the greatest uniqueness, and the body length, the antenna, the fore leg, the width of pronotum, the middle leg and the hind leg follow in that order.

The fifth instar larva: In the fifth stage, we obtained the results given in Tables 14 to 16 for the coefficient of correlation, the four factors, the communality and the uniqueness.

The intercorrelations of the seven aspects are given in Table 14 as the correlation matrix. All these coefficients show the positive values. All these correlations except $P < 0.01$ level of the body length with the antenna are very highly significant at the $P < 0.001$ level.

Table 14. The correlation matrix of seven variables for the fifth instar larva.

Variable	B	W	AT	R	F	M	H
B							
W	0.6097						
AT	0.3283	0.6230					
R	0.4984	0.5296	0.4222				
F	0.5198	0.7928	0.6886	0.5153			
M	0.4999	0.7231	0.7931	0.4885	0.8899		
H	0.5554	0.7923	0.6877	0.5376	0.8724	0.9028	

It is considered that the first factor loadings K_1 like the preceding four instars, which show all the positive coefficients as shown in Table 15, might act to promote growth of all the aspects as the general factor. The hind leg has the

highest value, and the middle leg, the fore leg, the width of pronotum, the antenna, the body length and the rostrum follow in that order. It is considered that the second factor loadings K_2 which show the positive form for the antenna, the fore leg, the middle leg and the hind leg, might act to promote growth as the group factor. However, we read the negative values which might act to check growth for K_2 of the body length, the width of pronotum and the rostrum. The middle leg has the highest value, and the antenna, the fore leg, the hind leg, the width of pronotum, the rostrum and the body length follow in that order. It is considered that the third factor loadings K_3 was also the group factor like the fourth instar larva. It might act to promote growth for the body length, the width of pronotum, the fore leg, the middle leg and the hind leg, while to check growth for the antenna and the rostrum. The body length has the highest value, and the hind leg, the fore leg, the width of pronotum, the middle leg, the rostrum and the antenna follow in that order. It is considered that the fourth factor loadings K_4 was also the group factor like the preceding third instar larva. We read the positive values regarding as the promoting growth factor for the body length, the rostrum, the middle leg and the hind leg, while the negative values regarding as the checking growth factor for the width of pronotum, the antenna and the fore leg. The body length has the highest value, and the middle leg, the rostrum, the hind leg, the antenna, the fore leg and the width of pronotum follow in that order.

Table 15. The factor loadings of seven variables for the fifth instar larva.

Variable	Factor loading	I	II	III	IV
B		0.6312	-0.3370	0.2163	0.1893
W		0.8531	-0.0593	0.1327	-0.1279
AT		0.7425	0.2645	-0.1047	-0.0014
R		0.6270	-0.2234	-0.0184	0.0961
F		0.8968	0.1693	0.1729	-0.0704
M		0.9007	0.3593	0.0627	0.1045
H		0.9113	0.1403	0.1855	0.0353

On the plane of the two factors K_1 - K_2 , the antenna, the fore leg, the middle leg and the hind leg are plotted in the first quadrant, while the body length, the width of pronotum and the rostrum in the fourth quadrant. On the plane of the two factors K_1 - K_3 , the body length, the width of pronotum, the fore leg, the middle leg and the hind leg are projected in the first quadrant, while the antenna and the rostrum in the first quadrant, while the antenna and the rostrum the fourth quadrant. On the plane of the factors K_1 - K_4 , the body length, the rostrum, the middle leg and the hind leg are distributed in the first quadrant,

while the width of pronotum, the antenna, the fore leg in the fourth quadrant. On the plane of the factors K_2 - K_3 , the fore leg, the middle leg and the hind leg are projected in the first quadrant, the body length and the width of pronotum in the second quadrant, the rostrum in the third quadrant, and the antenna in the fourth quadrant. On the plane of the factors K_2 - K_4 , the middle leg and the hind leg are plotted in the first quadrant, the body length and the rostrum in the second quadrant, the width of pronotum in the third quadrant, and the antenna and the fore leg in the fourth quadrant. On the plane of the factors K_3 - K_4 , the body length, the middle leg and the hind leg are projected in the first quadrant, rostrum in the second quadrant, the antenna in the third quadrant, and the width of pronotum and the fore leg in the fourth quadrant.

Table 16. The communality and uniqueness of seven variables for the fifth instar larva.

Variable	Communality	Uniqueness
B	0.5946	0.4054
W	0.7652	0.2348
AT	0.6322	0.3678
R	0.4526	0.5474
F	0.8677	0.1323
M	0.9552	0.0448
H	0.8858	0.1142

The communality of the middle leg is the greatest as indicated in Table 16 and the hind leg, the fore leg, the width of pronotum, the antenna, the body length and the rostrum follow in that order. Conversely, the rostrum shows the greatest uniqueness, and the body length, the antenna, the width of pronotum, the fore leg, the hind leg and the middle leg follow in that order.

Adult: In the sixth stage, we obtained the results given in Tables 17 to 19 for the coefficient of correlation, the four factors, the communality and the uniqueness. The intercorrelations of the seven aspects are given in Table 17 as the correlation

Table 17. The correlation matrix of seven variables for the adult.

Variable	B	W	AT	R	F	M	H
B							
W	0.8239						
AT	0.5881	0.4507					
R	0.5723	0.5615	0.4337				
F	0.7136	0.6076	0.7662	0.4961			
M	0.7208	0.5908	0.7885	0.4829	0.9286		
H	0.7682	0.7529	0.6988	0.5619	0.8782	0.8727	

matrix. All these coefficients show the positive values. All these correlations are very highly significant at the $P < 0.001$ level.

It is considered that the first factor loadings K_1 like the preceding five instars, which show all the positive coefficients as shown in Table 18, might act to promote growth of all the aspects as the general factor. The hind leg has the highest value, and the fore leg, the middle leg, the body length, the width of pronotum, the antenna and the rostrum follow in that order. It is considered that the second factor loadings K_2 , which show the positive form for the antenna, the fore leg, the middle leg and the hind leg, might act to promote to growth as the group factor. However, we read the negative values which might act to check growth for K_2 of the body length, the width of pronotum and the rostrum. The middle leg has the highest value, and the fore leg, the antenna, the hind leg, the body length, the rostrum and the width of pronotum follow in that order. It is considered that the third factor loadings K_3 was also the group factor like the the last instar larva. It might act to promote growth for the body length, the width of pronotum, the fore leg, the middle leg and the hind leg, while to check growth for the antenna and the rostrum. The width of pronotum has the highest value, and the hind leg, the body length, the fore, the middle leg, the rostrum and the antenna follow in that order. It is considered that the fourth factor loadings K_4 was the general factor like the first factor. We read the positive values regarding as the promoting growth factor for all these body parts. The middle leg has the highest value, and the antenna, the rostrum, the fore leg, the body length, the hind leg and the width of pronotum follow in that order.

Table 18. The factor loadings of seven variables for the adult.

variable	Factor loading	I	II	III	IV
B		0.8503	-0.1933	0.1242	0.0518
W		0.7692	-0.2933	0.2143	0.0154
AT		0.7567	0.2958	-0.0922	0.0940
R		0.6313	-0.2159	-0.0267	0.0928
F		0.8916	0.3187	0.1226	0.0696
M		0.8904	0.3449	0.1100	0.1012
H		0.9205	0.0684	0.1986	0.0424

On the plane of the two factors K_1 - K_2 , the antenna, the front leg, the middle leg and the hind leg are plotted in the first quadrant, while the body length, the width of pronotum in the fourth quadrant. On the plane of the factors K_1 - K_3 , the body length, the width of pronotum, the fore leg, the middle leg and the hind leg are distributed in the first quadrant, whilst the antenna and the rostrum in

the second quadrant. On the plane of the factors K_1 - K_4 , all these seven body parts are projected in the first quadrant. On the plane of the factors K_2 - K_4 , the antenna, the fore leg, the middle leg and the hind leg are plotted in the first quadrant, whilst the body length, the width of pronotum and the rostrum in the second quadrant. On the plane of factors K_3 - K_4 , the body length, the width of pronotum, the fore leg, the middle leg and the hind leg are projected in the first quadrant, while the antenna and the rostrum in the second quadrant.

Table 19. The communality and uniqueness of seven variables for the adult.

Variables	Communality	Uniqueness
B	0.7784	0.2216
W	0.7238	0.2762
AT	0.6774	0.3226
R	0.4544	0.5456
F	0.9163	0.0837
M	0.9341	0.0659
H	0.8932	0.1068

The communality of the middle leg is the greatest as indicated in Table 19, and the fore leg, the hind leg, the body length, the width of pronotum, the antenna and the rostrum follow in that order. Conversely, the rostrum shows the greatest uniqueness, and the antenna, the width of pronotum, the body length, the hind leg, the fore leg and the middle leg follow in that order.

DISCUSSION

The influence of the supposed growth factors varies according to the instar. Of course, these factors will be not single factor but a compound factors. The factors expressed at the adult insect are considered as the sum of all the influences acting upon each instar. We have supposed a few factors affecting *A. dallasi* growth.

The present authors extracted the four factors affecting growth for seven body parts. The first factor, at all times, is the general factor, but the rest factors except the fourth factor of the second instar larva and the adult, and the third factor of the first instar larva are the group factor.

In the body length as indicated in Figs. 7 to 12 all these six stages on the plane of the two factors K_1 - K_2 , are projected in the fourth quadrant. On the plane of the K_1 - K_3 , all these six stages are distributed in the first quadrant. On the plane of the K_1 - K_4 , the five stages except the third instar larva on the fourth quadrant are plotted in the first quadrant. On the plane of the K_2 - K_3 , all these six stages in the second quadrant. On the plane of the K_2 - K_4 , the five stages except the

third instar larva on the third quadrant are plotted in the second quadrant. On the plane of the K_3 - K_4 , the distributions are the same quadrant as in the K_1 - K_4 plane. Namely, for all six stages, the first, second and third factors act as the general factor of the positive, negative positive respectively, but the fourth factor acts as the group factor—the first group of the positive in the first, second, fourth, fifth and adult stages.

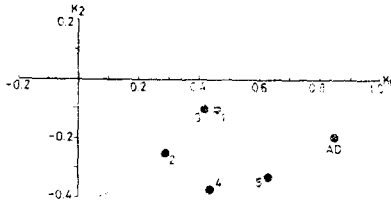


Fig. 7. The distribution of each stage on the two factors K_1 - K_2 plane for the body length.

K_1 : First factor K_2 : Second factor
 K_3 : Third factor K_4 : Fourth factor
 1: First instar larva
 2: Second instar larva
 3: Third instar larva
 4: Fourth instar larva
 5: Fifth instar larva
 AD: Adult

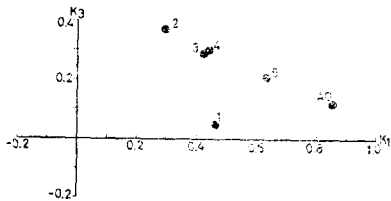


Fig. 8. The distribution of each stage on the two factors K_1 - K_3 plane for the body length. (Abbreviations are the same as in fig. 7).

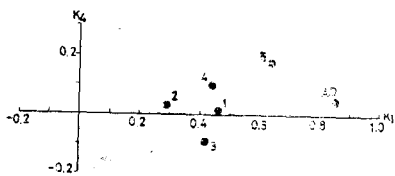


Fig. 9. The distribution of each stage on the two factors K_1 - K_4 plane for the body length. (Abbreviations are the same as in Fig. 7).

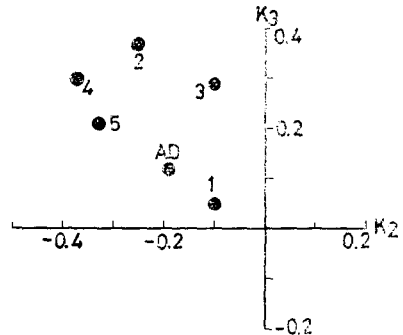


Fig. 10. The distribution of each stage on the two factors K_2 - K_3 plane for the body length. (Abbreviations are the same as in Fig. 7).

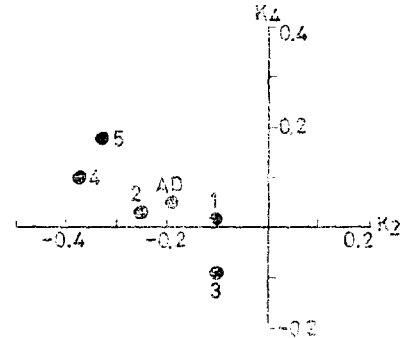


Fig. 11. The distribution of each stage on the two factors K_2 - K_4 plane for the body length. (Abbreviations are the same as in Fig. 7).

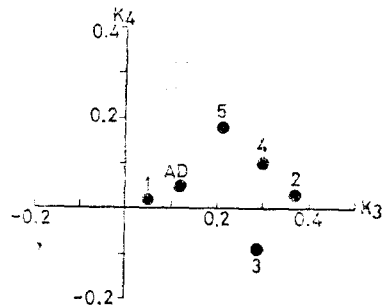


Fig. 12. The distribution of each stage on the two factors K_3 - K_4 plane for the body length. (Abbreviations are the same as in Fig. 7).

In the width of pronotum all these six stages on the two factors K_1 - K_2 , are projected in the fourth quadrant. On the plane of the K_1 - K_3 , the first instar, the fifth instar and the adult are distributed in the first quadrant, while the second, third and fourth instars in the fourth quadrant. On the plane of the K_1 - K_4 , four stages except the first and fifth instars on the fourth quadrant are plotted in the first quadrant. The distribution on the plane of the K_1 - K_3 and K_2 - K_3 was symmetrized by the y -axis. The distribution on the K_2 - K_4 and K_1 - K_4 planes showed the symmetry by the y -axis. On the plane of the K_3 - K_4 , the adult is plotted in the first quadrant, the second, the third and the fourth instars in the second quadrant, the first and fifth instars in the fourth quadrant. Namely, for all the stages the first and second factors act as the general factor of the positive, but the third and fourth factors act as the group factor. The third factor showed the growth promoting action for the first, fifth instars and adult stage, while the growth checking action for the second, third and fourth instars. The fourth factor showed the growth checking influence to the first and fifth instars, whilst the growth promoting influence to the second, third, fourth and adult stages.

In the antenna all these six stages on the plane of the two factors K_1 - K_2 are plotted in the first quadrant. On the plane of the K_1 - K_3 , the first, third and fourth instars are projected in the first quadrant, while the second, fifth instars and adult in the fourth quadrant. On the plane of the K_1 - K_4 , the second instar and adult are distributed in the first quadrant, whilst the first, third, fourth and fifth instars in the fourth quadrant. On the plane of the K_2 - K_3 , the distributions are the same quadrant as in the K_1 - K_3 plane. The projection on the K_2 - K_4 plane are the same as in K_1 - K_4 plane. On the plane of the K_3 - K_4 , the second instar and adult are plotted in the second quadrant, the fifth instar in the third quadrant, the first, third and fourth instars in the fourth quadrant. Namely, the first and second factors act as the general factor of the positive for all these six stages, whilst the third and fourth factors act as the group factor. The third factor showed the growth promoting action for the first, third and fourth instars, but growth checking action for the second, fifth and adult stages. The fourth factor showed the growth checking action for the first, third, fourth and fifth instars, but the growth promoting action for the second instar and adult stage.

In the rostrum the third and fourth instar larvae are plotted in the first quadrant on the plane of the two factors K_1 - K_2 , whilst the first, second, fifth instar larvae and adult in the fourth quadrant. On the plane of the K_1 - K_3 , the first and second instar larvae are plotted in the first quadrant, while the third, fourth, fifth instar larvae and adult in the fourth quadrant. On the plane of the K_1 - K_4 , the five stages except the third instar larva on the fourth quadrant are projected in the first quadrant. On the plane of the K_2 - K_3 the first and second instar larvae

are distributed in the second quadrant, the fifth instar larva and adult in the third quadrant, and the third and fourth instar larvae in the fourth quadrant. On the plane of the factors K_2-K_4 , the fourth instar larva is projected in the first quadrant, the third instar larva in the fourth quadrant, and the rest four stages in the second quadrant. On the plane of the K_3-K_4 , the first and second instar larvae are plotted in the first quadrant, the fourth, fifth instar larvae and adult in the second quadrant, and the third instar larva in the third quadrant. Namely, the first factor acts as the general factor of the positive, whilst the second, third and fourth factors act as the group factor. The second factor showed the growth promoting influence for the third and fourth instar larvae, but the growth checking influence for the first, second, fifth instar larvae and adult. The third factor showed the growth promoting action for the third, fourth, fifth instar larvae and adult. The fourth factor acts as the growth promoting action for the rest five stages except the third instar larva showing the growth checking influence. The present authors point out that the influence of the factors in the rostrum is most changeful.

In the fore leg all six stages on the plane of the two factors K_1-K_2 are plotted in the first quadrant. On the plane of the factors K_1-K_3 , the five stages except the second instar larva on the fourth quadrant are projected in the first quadrant. On the plane of the K_1-K_4 , the five stages except the fifth instar larva on the fourth quadrant are distributed in the first quadrant. The distribution on the plane of the K_2-K_3 is the same quadrant as in K_1-K_3 plane. The distribution on the plane of the K_2-K_4 is the same quadrant as in K_1-K_4 plane. On the plane of the two factors K_3-K_4 the first, third, fourth instar larvae and adult are projected in the first quadrant, the second instar larva in the second quadrant, and the fifth instar larva in the fourth quadrant. Namely, the first and second factors act as the general factor of the positive, while the third and fourth factors act as the group factor. The third factor acts as the growth promoting factor for the five stages of the first, third, fourth, fifth instar larvae and adult except the second instar larva showing the growth checking influence. The fourth factor acts as the growth promoting factor for the five stages except the fifth instar larva showing the growth checking influence.

In the middle leg all six stages on the planes of the K_1-K_2 , K_1-K_3 and K_2-K_3 are projected in the first quadrant. On the planes of the factors K_1-K_4 , K_2-K_4 and K_3-K_4 , five stages except the first instar larva on the fourth quadrant are plotted in the first quadrant. Namely, the first, second and third factors act as the general factor of the positive, whilst the fourth factor acts as the group factor the negative group of the first instar larva and the positive group of the rest five stages.

In the hind leg all the six stages on the planes of the K_1-K_2 , K_1-K_3 , K_1-K_4 , K_2-K_3 , K_2-K_4 and K_3-K_4 are plotted in the first quadrant. Namely, all the four factors act as the general factor. The present authors found that the distribution of the factors in the hind leg is most monotonous.

The authors point out that the difference of the total length between the all body parts is due to the composite influence of the factors, the difference of the distribution on the planes of the four factors.

The first factor shows the positive sign for all the variables. The second factor shows the positive sign for the antenna, the fore, middle and hind legs, the negative sign for the body length and the width of pronotum, and the mixed sign for the rostrum. The third factor shows the positive sign for the body length, the middle and hind legs, whilst the mixed sign for the rostrum, the width of pronotum, the antenna and the fore leg. The fourth factor shows the positive sign for only the hind leg, while the mixed sign for the body length, the width of pronotum, the antenna, the rostrum, the fore and middle legs. Table 20 gives the influence of the four factors on each part of the body.

Summing up, all these seven body parts may be grouped into three sets distinguishable by the growth influence according to the character of the factor. The first group of the body length, the middle leg and the hind leg, the second group of the fore leg and the third group of the width of pronotum, the antenna and the rostrum. But the second group is similar to the first group in the influence of the factors.

Table 20. The distribution of each instar on the four quadrants divided by each two factor for each part of the body.

Variables	Factors plane	K_1-K_2	K_1-K_3	K_1-K_4	K_2-K_3	K_2-K_4	K_3-K_4
B		IV	I	I IV ₃	II	II	I IV ₃
W		IV	I ₁₅₆ IV	I IV ₁₅	II ₁₅₆ III	II III ₁₅	I ₆ II IV ₁₅
AT		I	I ₁₃₄ IV	I ₂₆ IV	I ₁₃₄ IV	I ₂₆ IV	II ₂₆ III ₅ IV
R		I ₃₄ IV	I ₁₂ IV	I IV ₃	II ₁₂ III ₅₆ IV	I ₄ II IV ₃	I ₁₂ II III ₃
F		I	I IV ₂	I IV ₅	I IV ₂	I IV ₅	I II ₂ IV ₅
M		I	I	I IV ₁	I	I IV ₁	I IV ₁
H		I	I	I	I	I	I

I to IV: First quadrant to fourth quadrant

I to 6: First instar to adult, and no arabian number indicates the all stages or the rest all stages.

K_1 to K_4 : First factor to fourth factor

The rest abbreviations are the same as in table 1.

Averaging the communality of the all six stages for the seven body parts, we can read the following order, the middle leg 0.9033, the hind leg 0.8822, the fore leg 0.8345, the antenna 0.6757, the width of pronotum 0.5062, the rostrum 0.4401 and the body length 0.4385. Namely, the communality of the middle leg is

the highest, whilst that of the body length is the lowest. On the contrary, the uniqueness of the body length is the highest and that of the middle leg is the lowest. Averaging the communality of the seven body parts for the instar larvae, we can read the value of the first instar larva 0.5957, the second instar larva 0.4769, the third instar larva 0.6967, the fourth instar larva 0.7386, the fifth instar larva 0.7361 and the adult 0.7682. In other words, the present authors find out that the communality, that is, the contribution of the growth factor is tend to increase according to the development of the instars.

SUMMARY

Applying the factor analysis to the values standardized from the measured values for instars in seven body parts of *A. dallasi*, it is summarized as follows: 1. All seven aspects are found to have the four growth factors. 2. The first factor is acceptable as a general factor and a growth promoting factor, whereas the rest three factors are indicated as a group factor in most cases. 3. The seven aspects are classifiable into three groups—the first group of the body length, the middle leg and the hind leg, the second group of the fore leg, and the third group of the width of pronotum, the antenna, the rostrum. But the second group is similar type to the first group in the influence of the factors. 4. The communality of the middle leg is the highest, while that of the body length is the lowest. The uniqueness of the middle leg is the lowest, while that of the body length is the highest. 5. The contribution of the growth factor tends to increase according to the development of the instars. 6. The correlation for a young instar larva has a tendency to become low, but that for an advanced instar larva tends to become high.

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