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OBSERVATIONS ON THE ENVIRONMENTAL REGULATION
OF HYPOPIAL FORMATION IN THE FISH-MITE LARDOGLYPHUS KONOI

BY

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ABSTRACT

Correlations of the seasonal counts of the hypopi formed in laboratory culture to the atmospheric humidity and temperature during the periods were estimated. The estimates have revealed that the correlations are not statistically significant. By another series of experiments it has been found that overcrowding and scarcity of food are also not responsible for the hypopus formation of L. konoi. It is suggested that the ability of the protonymphs to transform to the hypopi may be hormone—dependent, and that the variation among protonymphs, of a same population or in different species, to form the hypopi, may be due to variation in the internal build up and its capacity to respond to the external characters to produce the hormone or hormones concerned.

RÉSUMÉ

Les corrélations pouvant exister entre la formation d’hypopes en laboratoire, la température et l’humidité atmosphérique ont été estimées. Ces corrélations ne sont pas statistiquement significatives.

Une autre série d’expériences a démontré que la quantité de nourriture n’était également pas responsable de la formation des hypopes de L. konoi.

Il est suggéré que la possibilité des protonymphes de se transformer en hypopes peut être sous la dépendance d’une hormone. La variabilité constatée chez les protonymphes d’une même population ou dans différentes espèces, pour former des hypopes, peut être due à la variabilité du milieu intérieur et à sa capacité de répondre aux facteurs externes pour produire l’hormone ou les hormones concernées.

INTRODUCTION

The hypopus which is heteromorphic to all other stages of life history occurs in the life cycle of a number of Astigmata. The appearance of the hypopus in the life cycle provides that species with a very effective dispersal mechanism. Kuo and Nespitt (1970) have observed that apparently the factor or factors responsible for hypopial formation vary in different species. So knowledge about the factors which would induce the hypopial formation in any species will be of importance.

Hypopial formation has been discussed by Sokolov (1956), Schulze (1924a, b), Polezhaev (1938a, b, 1940), Sorokin (1951), Griffiths (1966), Cutcher and Woodring (1969), Kuo and Acarologia, t. XVI, fasc. 1, 1974.
NESBITT (1970), and reviewed by WALLACE (1960) Woodring (1963), HILSENHOFF and Dicke (1963) and CHMIELEWSKI (1967). These workers have implicated a number of environmental factors like temperature, R.H., pH. of food, mould growth, overcrowding, CO₂, waste product accumulations and quantity of food, as contributing to hypopial formation. GRIFFITHS (1966) made the critical observation that protonymphal *Acarus siro* which moulted to hypopi spent more time in the protonymphal stage than those which moulted directly to the tritonymph. CUTCHEr and Woodring (1969) suggested that any adverse environmental condition which slowed the development of the protonymph, or when the environment becomes less suitable for its rapid growth, it will induce physiological change in the protonymph that will result in the protonymph producing a deutonymph (hypopus) instead of a tritonymph.

According to published results, the more common factors implicated in the formation of hypopi are temperature, relative humidity, quality and quantity of food, overcrowding and waste products accumulation. The present paper is to report results which would indicate that among these, temperature, relative humidity, overcrowding and quantity of food have no influence on the formation of hypopi in the mite *L. konoi*.

*Effect of atmospheric temperature and humidity*

**Material and Methods**

Stock cultures of the mites were maintained in screwcap jars (4 × 5 cm) with dried anchovy serving as the substrate. The depletion in the substrate was made good by the addition of a suitable quantity of freshly dried anchovy in the second week of every month. The cultures were kept in an open space within the laboratory, well protected against rats and other similar poachers.

For the experiment, one fully infested, entire anchovy was withdrawn from a culture in the first week of every month. While thus handling the adults as well as the developing stages including the hypopi were capable of creeping out, and so lest this should happen and vitiate the counts, the anchovies soon after withdrawal from the stock cultures were immersed individually in formalin, so as to kill and immobilise the different stages of the mite adhering to them. After a sufficient time to ensure the death of all the stages, the adult hypopi and the different stages were carefully dislodged from the fish with a fine brush to settle down on the bottom of the container. The formalin in which the dead stages were suspended was then made up to a total volume of 10 cc. This was then stirred well and a subsample of 1 cc was withdrawn. The number of hypopi present in this subsample was counted under a binocular microscope. This figure was then multiplied by 10 which gave the estimates of the hypopi occurring on each experimental sample of the anchovy.

The experiment was started in December 1971 and terminated in November next year. The average values of the atmospheric humidity and temperature for each month during this period were computed from the values of the same for each day of the month which again were in their turn calculated from readings of these factors for every hour of the day, as provided by the Government observatory.

*Acarologia*, t. XVI, fasc. 1, 1974.
RESULTS

For the experiment under consideration three of the cultures were used and a fully infested anchovy was withdrawn every month from each of the culture. The average of the counts of the hypopi which occurred on all the three experimental anchovies, in each month, and the average monthly values of the relative humidity and temperature for the corresponding months are given in table I.

Table I. — Showing the counts of Hypopi each month

<table>
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<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of hypopi</td>
<td>71</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>RH %</td>
<td>82</td>
<td>71</td>
<td>74</td>
<td>71</td>
<td>79</td>
<td>86</td>
<td>84</td>
<td>88</td>
<td>86</td>
<td>85</td>
<td>88</td>
<td>85</td>
</tr>
</tbody>
</table>

The data in table I were analysed statistically. The correlation between hypopus population and relative humidity was found to be 0.383. The correlation of the hypopus number with temperature was found to be 0.500. Significance of these correlation coefficients was tested by using the students “t” test. The correlation between hypopus and R.H., and hypopus and temperature were found to be not significant. This would suggest that the formation of the hypopial stage of *L. honoi* is not influenced by the atmospheric humidity or temperature.

Effect of overcrowding and scarcity of food

**Material and Methods**

One pair each of the adults were placed inside two rearing chambers (cavity blocks with lids closed) and in another two, five pairs each. Chips of 0.5 grms. weight were sliced off from a same dried anchovy and one of these chips was deposited in each of the rearing chambers. All the four breeding chambers were maintained at room temperature and humidity. After fourteen days the number of hypopi present in each chamber was counted under a binocular microscope.

**Results**

The number in respect of the adult and hypopi present in each chamber is given in table 2.
TABLE 2. — Showing the number of adults and hypopi in the crowded and less crowded chambers

<table>
<thead>
<tr>
<th>Chamber Type</th>
<th>Adult No.</th>
<th>Hypopi No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less crowded chamber</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>309</td>
<td>230</td>
</tr>
<tr>
<td>2</td>
<td>410</td>
<td>220</td>
</tr>
<tr>
<td>Crowded chamber</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2032</td>
<td>nil</td>
</tr>
<tr>
<td>2</td>
<td>2475</td>
<td>nil</td>
</tr>
</tbody>
</table>

The data in table 2 will show that after fourteen days, the hypopi were present only in the chambers which started with the solitary pair of adults and that they were absent in the other two chambers. In other words the hypopi were formed only in the less crowded chambers. This is suggestive that the formation of hypopi of L. konoi is also not influenced by overcrowding.

It will be noticed that initially an equal weight of food was placed in all the four chambers. But the relative intensity of the adults was varied in the two sets of rearing chambers, both at the start and at the end of the experiment. When the experiment was concluded, in the less crowded chambers they varied from 309 to 410, whereas in the other two it varied from 2032 to 2475. This will indicate that in respect of the food supply the overcrowded chambers were at considerable disadvantage than the less crowded chambers. Nevertheless no hypopus was formed in the overcrowded chambers. So the inference seems to be justified that hypopus formation of L. konoi is not influenced by the scarcity of the food also.

DISCUSSION

As already stated environmental factors such as temperature, relative humidity, quantity of food, and overcrowding are some of the factors implicated in the formation of hypopi. (WooRING 1963, HILSENHOFF and DICKE 1963, CHMIELEWSKI 1967). But the results of the present study are to indicate that in the case of L. konoi these factors are not functional in the formation of the hypopi. This confirms Kuo and NESBITT's (1970) contention that factors responsible for hypopial formation vary in different species. GRIFFITHS (1966) and CUTCHER and WOODRING (1969) have indicated that any factor that would lengthen the duration of the protonymph would lead to hypopial formation. We have evidence (unpublished data) that in the present species a rise in temperature or fall in R. H. below an optimum level of 83 % are adverse to the development of protonymph and will prolong the duration of protonymph. But according to the present study even though there is no statistically significant correlation, the number of hypopi that formed was lesser during higher temperatures, than during lower temperatures. Similarly the number of hypopi was also lesser during several of the months when the R.H. was lower than 83 %. This shows that factors which would prolong the duration of protonymphal stage do not entirely regulate the formation of hypopi in the present species.

This suggestion is further strengthened by the following also. If the hypopus formation is in response to an adverse factor or factors, all the protonymphs living under those given conditions should transform into the hypopi. In the present species in a given culture or a natural stock, all the protonymphs do not transform into the hypopi; a few transform into the hypopi and the others directly into the tritonymph.
A similar case of differential response to the same set of environmental factors have been reported by Griffiths (1966) who found that among two populations of *Acarus siro* one formed hypopii in response to starvation and another seldom formed hypopii under similar conditions. So it appears correct to presume that the capacity among some individuals alone in a given culture, or, certain population alone of a given species, to respond to a particular set of environmental factors and change into the hypopial stage, and for the others to be unresponsive to the same set of conditions may be dependent on the internal make up of the individuals concerned.

Cutcher and Woodring (1969) have suggested that apolysis of hypopii is directly regulated by hormones. It may be reasonable to presume that in the same way, formation of hypopii is also regulated by hormones. No doubt hormones are also to a large extent regulated by environmental factors. But the response of an organism to the factor or factors which would induce the formation of a hormone and the level of secretion of a hormone are dependent on internal factors like the physiological state, biochemical content and nervous co-ordination of the individual. This may explain the differential response among members of the same population of protonymph to the same set of environmental conditions. This hypothesis will easily explain the variation of environmental factors responsible for hypopial formation in the various species also.

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References


