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FEEDING ON EGGS BY SPIDERLINGS OF *ACHAEARANEA TEPIDARIORUM* (ARANEAE, THERIDIIDAE), AND THE SIGNIFICANCE OF THE QUIESCENT INSTAR IN SPIDERS[1]

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ABSTRACT

Feeding on inviable eggs by spiderlings is known to occur in several families. This activity has been observed in the first (quiescent) instar only, leading to the general belief that this first instar always undertakes the utilization of such eggs. However, the present study indicates that egg feeding occurs in the second instar in *Achaearanea tepidariorum* (Theridiidae), with the reduction in time period of the quiescent instar. There seems to be a tendency in the Theridiidae (and, perhaps, in some related families as well) toward the elimination of the quiescent instar. Egg-feeding considerably extends the life span of spiderlings and, sometimes, provides enough nourishment to carry spiderlings to the third instar without additional food intake.

INTRODUCTION

It should be readily apparent to arachnologists that, in many cases, some of the spiderlings emerging from an egg sac are heavier than the rest, having a more bulky abdomen. This condition is correlated with the presence of dried eggs inside the sac. The consumption of unfertilized (or otherwise inviable) eggs is known to occur in several families of spiders (Lecaillon, 1904; Holm, 1940; Schick, 1972), although seldom observed and photographed (Peck and Whitcomb, 1970). This feeding activity has been directly observed only in the first instar (i.e., before the first true molt), leading many workers to suppose that egg-feeding takes place only in this instar. However, the data herein reported on *Achaearanea tepidariorum* (C. L. Koch) reveal the presence of a different strategy.

MATERIALS AND METHODS

Several adult female spiders were kept under controlled conditions to provide fresh eggs of known age. Egg sacs were separated from the maternal web and kept in a constant temperature (24.5 ± 0.3°C) cabinet. Some hatched spiderlings were individually isolated in vials before the first true molt (i.e., while in the first instar). Others were permitted to molt and emerge from the sac, and then were isolated. These two groups of

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spiderlings were kept without food to measure their survival capacity. The vials were checked daily and the number of dead spiderlings recorded. Groups of eggs were checked daily under the dissecting microscope to study morphological changes related to reversion, rupture of chorion and first molt. Some eggs were submerged in paraffin oil according to the method of Holm (1940) to render the chorion transparent so that the embryo could be observed.

RESULTS AND COMMENTS

In the group of spiderlings isolated before the first molt, all individuals had died by the 23rd day. In the group of individuals isolated after emergence from the egg sac, (thus, after the first molt), about 25% survived beyond the 23rd day (Fig. 1). Furthermore, over 3% of these spiderlings molted to the third instar (Table 1).

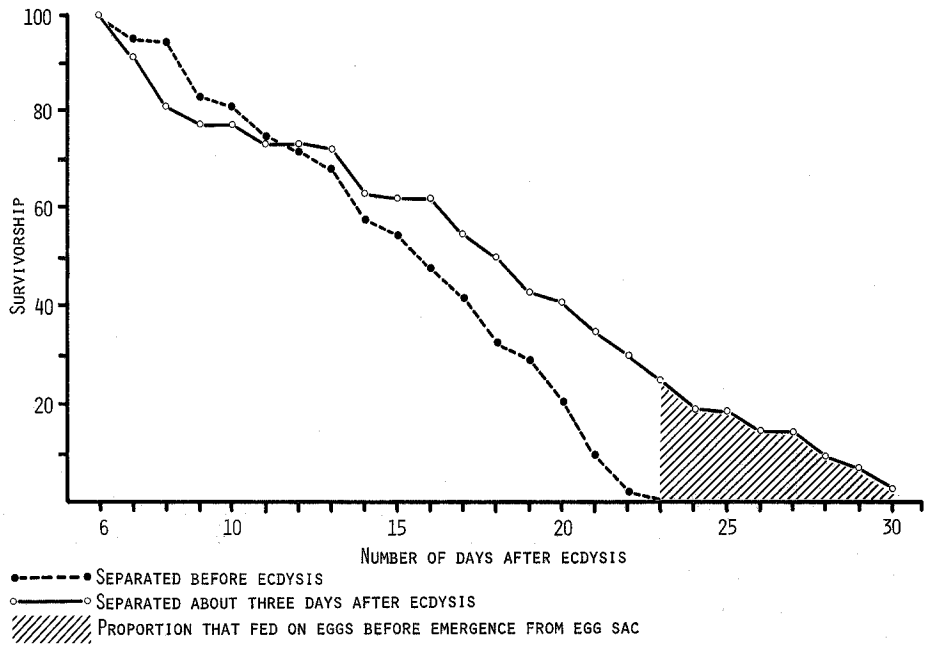

Fig. 1.—Survival in unfed spiderlings of *Achaearanea tepidariorum* kept individually isolated.

Early Development—During their development, all spiders pass through one or more quiescent stages immediately following eclosion. A variety of names has been applied to these stages in the literature: incomplete stadia (Holm, 1940), nymphs (Vachon, 1953) and deutova (Gertsch, 1949), among others. Many embryonic characteristics are retained, e.g., lack of segmentation in the appendages and traces of abdominal segmentation in some species. Hairs and pigmentation are absent, and motility is very poorly coordinated.

In species with more than one such stages, feeding on inviable eggs seems to be a widespread phenomenon in the families Scytodidae (Hite, et al., 1966; Galiano, 1967), Clubionidae (Lecaillon, 1904; Peck and Whitcomb, 1970), Gnaphosidae (Holm, 1940) and Thomisidae (Schick, 1972). However, species with only one quiescent stage of short

Table 1.–Survival in unfed spiderlings (*Achaearanea tepidariorum*) kept individually isolated ([1] molted to third instar).

	Isolated immediately after emergence from egg sac		Isolated just before ecdysis (or during the process)	
Day after ecdysis	Numbers	Percentage	Numbers	Percentage
6	90	100.00	77	100.00
7	82	91.11	74	96.10
8	73	81.11	73	94.80
9	69	76.67	64	83.12
10	60	76.67	62	80.50
11	66	73.33	58	75.33
12	66	73.33	56	72.73
13	65	72.22	52	67.53
14	57	63.33	45	58.40
15	56	62.22	43	55.84
16	56	62.22	37	48.05
17	50	55.56	33	42.86
18	45	50.00	26	33.77
19	39	43.33	22	28.57
20	37	41.11	16	20.78
21	31	34.45	8	10.39
22	27	30.00	2	2.60
23	22	24.45	0	–
24	17	18.89		
25	16	17.78		
26	13	14.45		
27	13	14.45		
28	8	8.89		
29	5	6.67		
30	3[1]	3.33		

duration, like *A. tepidariorum* and possibly all theridiids, have their digestive tracts still full with yolk (Dawydoff, 1949) and feeding is unlikely to occur, if in fact it is not impossible. This assumption is further supported by the particularly feeble and uncoordinated movements in this second group. Yet survival in this stage in *A. tepidariorum* is very high (98.46% in laboratory rearings).

Several literature reports on feeding by this stage in the family Theridiidae (Juberthie, 1957; Bouillon, 1957; Kaston, 1970) appear to be the result of incomplete observations. Feeding does occur inside the egg sac by the second-instar spiderlings, as is reported herein (see below) but not by the quiescent instar. Information on related families is completely lacking.

Adaptative value of this first instar has been questioned by Gertsch (1949), since it represents an unnecessary exposure with apparently no adaptive gain (the stage could have been passed inside the egg). This situation is comparable to the life cycle of insects with complete metamorphosis, in which a quiescent stage also occurs (pupa). But in the latter case the pupa follows active feeding instars, and provides a protective structure for important physiological and morphological changes. It has been suggested by Schick (1972) that the sole function of quiescent stages in spiders is to allow feeding on inviable eggs, to produce stronger spiderlings in the next instar. This latter hypothesis seems tenable where the phenomenon is known to occur. In theridiids, however, and perhaps in

other related families, there is an associated tendency for temporal reduction of the quiescent instar.

Nomenclatural Systems–Presently used terminology for different stages in the development of spiders is chaotic. Some workers seem to ignore or misunderstand terms used by previous investigators. In other cases, apparent conflicts between systems are just the effect of differences among the species under study. For instance, the phenomenon of "reversion" is considered a basic turning point in some systems, and totally ignored by others.

After analysis of the literature and comparisons among the main systems and opinions, I have concluded that all developmental sequences can be grouped into three nomenclatural categories. This division is based on two simple characteristics: 1) Reversion or eclosion can be considered the end of the embryonic period; 2) Free hunting stages can be considered totally different or a nomenclatural continuation of quiescent stages (Fig. 2).

The three categories are characterized as follows:

I. The embryonic stage is defined as continuing until eclosion. The same nomenclature is used for the quiescent and active instars. This category includes the ideas of Ewing (1918), Hite, et al. (1966), and Peck and Whitcomb (1970).

II. The embryonic stage is also considered to continue until eclosion. However, a different nomenclature is used for the quiescent and active stages. Authors supporting this system are Holm (1940), Juberthie (1964), Eason and Whitcomb (1965), and Gertsch (1949).

III. The embryonic stage is considered to end with reversion. A different nomenclature is used for the quiescent and active instars. This system was basically developed by Vachon (1953, 1957) and was followed or modified by Galiano (1967, 1969) and Schick (1972).

Reversion (from the German *umrollumg*; *inversion* in French and Spanish) is, basically, the moving of the ventral structures derived from the germ layer to a dorsal position (Dawydoff, 1949). It is exclusively characteristic of arachnids, and well studied in the Araneae by embryologists, although largely overlooked or totally ignored by workers doing life history studies.

In *A. tepidariorum* reversion is completed by the fifth day (at 217 hours, according to Montgomery, 1909). As a result of reversion and of developmental changes associated with it, the exuvial liquid is absorbed by the embryo and then the chorion outlines the body and the appendages. This new appearance is easily detected, even with the naked eye.

Four days after reversion, eclosion occurs (i.e., shedding of the chorion and vitelline membrane, simultaneously in this species). The stage resulting after eclosion is then not enveloped in any membrane and molts directly into the active instar. The egg teeth were not observed, but the egg inclosure ruptures along the anterior margin of the clypeus.

Duration of the First Instar–The first instar is composed, then, of a single stage of a two-day duration. Almost half of the duration of this quiescent instar is actually the pharate second instar. That is, the second instar is anatomically achieved (apolysis) some 30 hours after eclosion, but the old skin is not shed (ecdysis) until some 18 hours later. The nomenclature here follows Jenkin (1966) and Jenkin and Hinton (1966). The hairs and well-pigmented eyes of this pharate second instar can be easily seen through the first instar skin.

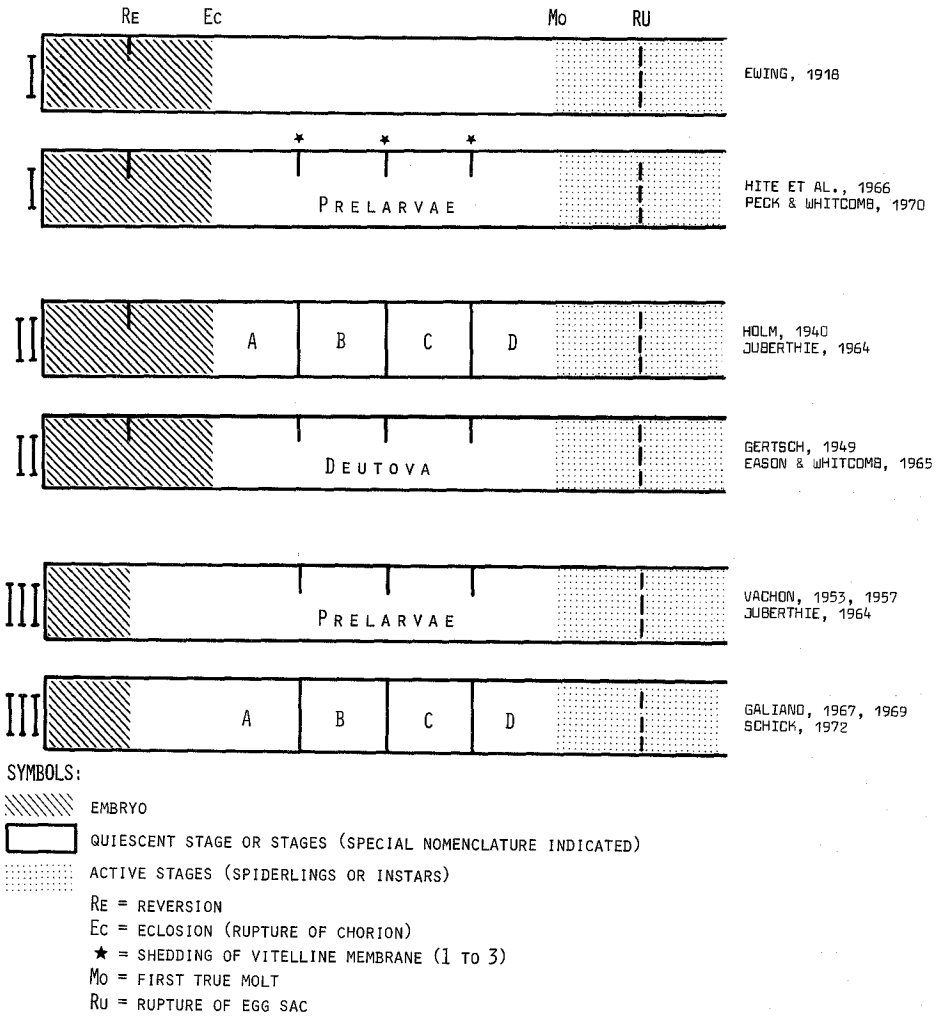

Fig. 2.–Principal nomenclatural systems in spider embryology and early development.

Feeding–After ecdysis the first active spiderlings (second instar) remains inside the egg sac for four days, a period during which the spiderlings normally feed on eggs that did not complete development. This period seems to vary with ambient temperature and other ecological factors such as wind and humidity; after which one or sometimes two holes are cut in the sac wall, and the spiderlings emerge. When a large number of inviable eggs are available and few spiderlings develop they molt to the next instar without any additional food intake (Table 1, 30th day).

CONCLUSIONS

Very short duration of the quiescent period (i.e., first instar) in this species seems to indicate a trend toward the elimination of this stage in the family Theridiidae and related groups. This elimination would be possible since its presumable function, (Schick, 1972) seems to be taken by the first active instar (second instar) during the period of life within

the egg sac. Utilization of inviable eggs, originally a role for the quiescent instar (1 to 4 stages), seems to be undertaken by the second instar with a consequent temporal reduction of the first instar.

Difference in survival in the two groups of spiderlings is clearly attributed to egg-feeding before abandonment of the egg sac. If such feeding does not take place, the maximum life expectancy for a starving second instar spiderling is 22 days (Table 1). The spiderlings that feed on eggs, even though this feeding may not be sufficient in itself to lead to molting, stand a greater chance for survival since the life span is extended considerably by such early nutritional procurement.

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