THE VALUE OF OVIPOSITIONAL ABILITY IN TICK TAXONOMY [1]

BY

S. K. NAGAR

INTRODUCTION.

Modern systematics stipulates utilization of as many features as possible in characterizing a species. MAYR et al (1953) suggest features which could be used in taxonomy. It is well known, however, that different groups, because of their peculiar features, are amenable only to certain types of studies. Some animal groups lend themselves well to behavioral studies, others to physiological or ecological investigations. The task of a taxonomist, therefore, is not only to apply the suggested features but also to find out features which could be of significance in taxonomy of a given group of animals.

The present study has this taxonomic bias and attempts to bringforth evidences to show that ovipositional rate of a tick species, perhaps, has some value in the taxonomy of ixodid ticks. Adult ixodid ticks feed, mate, and lay eggs only once in their life time. The fact that there is a marked variation in the number of eggs laid by different tick species and by the individuals of the same species is as well known as it is poorly understood.

It has been suggested that the factors, influencing the number of eggs laid by a tick, vary from climatic to nutritional conditions. Advocates of climatic factors are : HUNTER and HOOKER (1907), MACLEOD (1953) and ARTHUR (1951). Those who believe in the variability in the number of eggs due to nutrition are NUTTALL (1913), CUNLIFFE (1914), OSWALD (1939), ASANUMA (1944, *a*, *b*) KITAOKA and YAJIMA (1958), and ACHAN (1961).

REVIEW OF LITERATURE.

Detailed studies on the ovipositional ability of ticks are few and are limited to those of LEGG (1939), HITCHCOCK (1955), and KITAOKA and YAJIMA (1958) on

1. Adapted from a part of the thesis submitted to the Graduate School, University of Rhode Island, U.S.A., in partial fullfilment of the requirement for the Doctoral Degree in Biological Sciences.

Boophilus australis, *B. microplus*, and *B. caudatus* respectively : BISHOPP and SMITH (1938) indicated that *Dermacentor variabilis* produced from 4,500 to 6,000 eggs per female laid over a period of 14 to 32 days with as many as 800 eggs being laid in a single day. BISHOPP and WOOD (1938) include some quantitative data on *D. albipictus* and *nigrolineatus* and ALLRED and ROSCOE (1956) on *D. parumapertus*. Oviposition in *Haemaphysalis campanulata* and *H. bispinosa* has been studied by ASANUMA (1944-1947) and KITAOKA and YAJIMA presented their dara on *H. ias* in 1958. SNOW and ARTHUR (1966) record their observation on *Hyalomma anatolicum anatolicum* only recently. ARTHUR (1951) has reported egg laying in *Ixodes hexagonus*, while OSWALD (1939) in *Rhipicephalus bursa*, and SAPRE (1944), LOMBARDINI (1950) and ACHAN (1961) have shown egg laying potential in *Rhipicephalus sanguineus*.

MATERIAL & METHOD.

Unengorged adults specimens of *Dermacentor variabilis* were collected in the field from Jamestown, Rhode Island, U.S.A., in June 1965. HOREN'S (1954) modified flag technique was employed for collecting the ticks. Males and females were separated into containers in the field.

Rhipicephalus sanguineus unengorged adults were collected from a house in Cranston, R. I., U.S.A., where this tick had become a nuisance.

Both the tick species were fed on rabbits (18 ♀♀ & 12 ♂♂ on each rabbit ear) using the ear bag technique (BAILEY, 1960). Unfed females of *D. variabilis* were weighed before they were allowed to feed. Each tick was marked for identification in the begining. But it was found that as the ticks increased in size the identification mark was obliterated. Rough sketches of the ears of rabbit with ticks attached were, therefore, made to facilitate the identification of the tick. *R. sanguineus* females were not weighed because these are fast moving, and too small and light to be weighed quickly and accurately.

Ear bags were examined every day at fixed time and those ticks which detached were removed. At no time was a tick plucked off the host. The ticks were weighed (this weight is referred to as the initial weight in the text) and isolated in a square plastic box (3.0 cm × 3.0 cm × 1.5 cm) and maintained in a glass desiccator at 80 % R. H. and 25° ± 5° C. The relative humidity was controlled by using a saturated ammonium sulphate solution (WINSTON and BATES, 1960). Each morning the number of eggs laid by a tick was counted.

RESULTS.

For each species of tick 30 females are recorded. The weight range in *R. sanguineus* is between 59.8 and 205.1 mg and in *D. variabilis* it is between 117.0 and 822.0 mg. Tables 1 and 2 indicate that ticks with lighter initial weight laid smaller

number of eggs. No tick which had voluntarily dropped failed to lay eggs. When values given in Tables 1 and 2 were plotted, a linear relationship was found. Linear regression analysis was then carried out on the computer. The results computed are presented in Figures 1 and 2 and the values of Term A and B resulted in an empirical formula as follows :

R. sanguineus $N = 13.939\ W - 77.069$
$= 13.939\ (W - 5.52)$

D. variabilis $N = 7.733\ W + 191.47$
$= 7.733\ (W + 24.76)$

TABLE 1.

Dermacentor variabilis : Total number of eggs deposited by female ticks.

Reference number of tick	Unfed weight (mg)	Initial weight (mg)	Pre-oviposition period	Ovi-position period	Total number of eggs deposited
1.	6.1	117.0	8	14	725
2.	6.0	121.5	7	15	1214
3.	5.7	167.5	6	20	1532
4.	5.8	176.5	6	23	1583
6.	5.4	225.2	6	21	1794
7.	5.5	250.0	6	20	1952
8.	5.5	266.0	6	20	1991
9.	6.1	302.0	7	19	2593
11.	5.9	350.0	7	17	2780
12.	5.8	387.5	6	26	3441
13.	6.1	397.1	6	25	3443
14.	6.0	403.0	8	28	3066
15.	5.5	422.0	9	24	3756
16.	5.7	480.0	7	28	3754
17.	6.1	482.0	7	27	4103
18.	5.6	499.0	7	24	4242
19.	6.1	511.0	6	31	3684
20.	5.7	528.0	6	27	4114
22.	6.1	535.0	9	27	4917
23.	5.8	551.5	7	28	4972
24.	5.5	555.5	6	26	5061
25.	5.7	570.0	7	28	5188
26.	5.6	610.0	8	26	5241
27.	5.6	628.5	8	29	5816
29.	6.0	677.0	8	27	5837
30.	5.9	680.0	9	30	6108
31.	5.5	696.0	7	26	6330
32.	5.7	722.0	7	28	6185
33.	5.7	807.0	7	28	7264
34.	5.6	822.0	8	27	7216

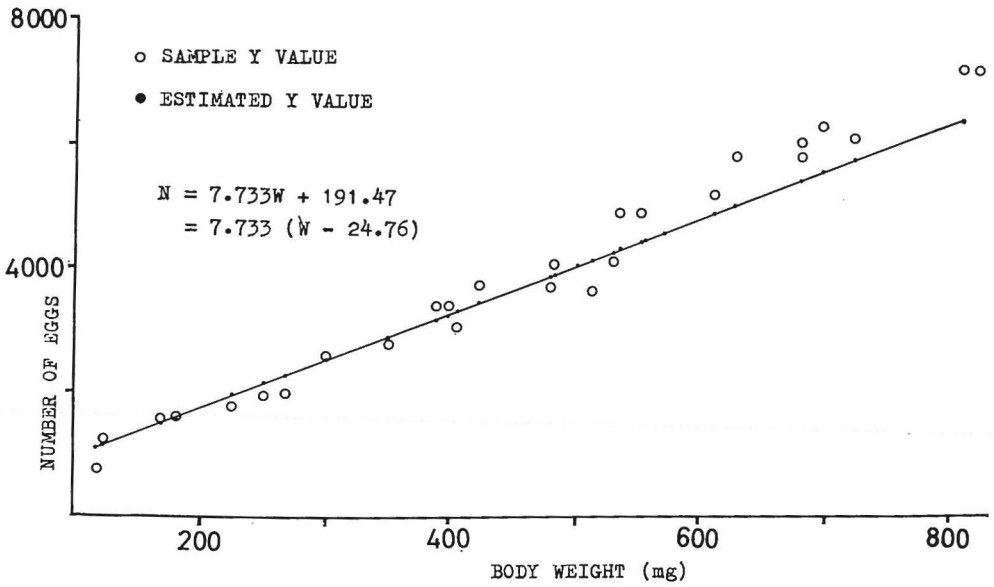

FIG. 1. — *Dermacentor variabilis* : linear relationship between body weight and number of eggs.

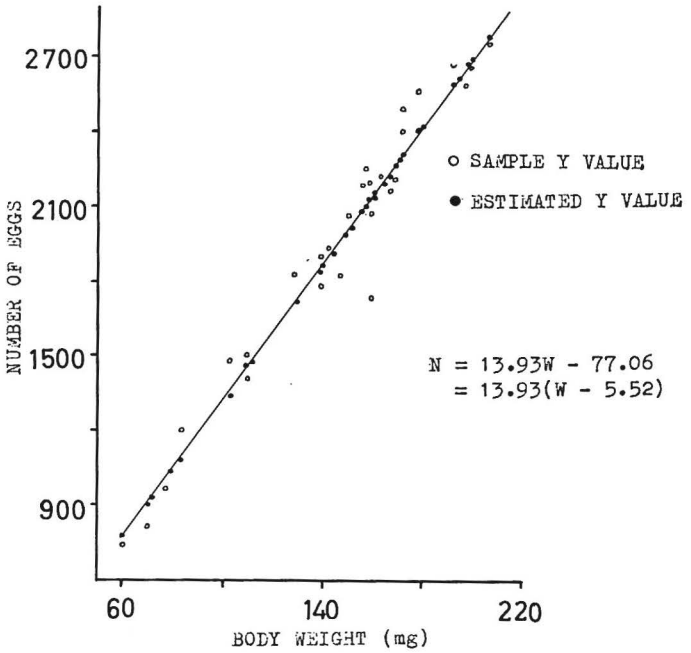

FIG. 2. — *Rhipicephalus sanguineus* ;
linear relationship between body weight and number of eggs.

TABLE 2.

Rhipicephalus sanguineus : Total number of eggs deposited by female ticks.

Reference number of tick	Initial weight (mg)	Pre-oviposition period	Ovi-position period	Total number of eggs deposited
1.	50.8	4	14	745
2.	70.2	4	11	808
3.	71.0	5	13	943
4.	77.0	6	12	966
5.	83.3	2	16	1097
6.	102.0	3	15	1463
7.	109.7	5	15	1498
8.	110.0	6	15	1412
9.	129.0	3	15	1835
10.	138.0	3	14	1771
11.	138.4	3	19	1904
12.	143.1	3	17	1925
13.	148.8	4	15	1824
14.	150.5	3	12	2056
15.	155.9	3	19	2192
16.	156.1	3	19	2256
17.	158.5	3	17	2184
18.	158.7	3	15	2020
19.	159.3	3	15	1724
20.	163.0	3	18	2218
21.	166.0	4	18	2155
22.	167.4	3	16	2217
23.	170.5	3	16	2495
24.	170.7	3	18	2401
25.	178.0	3	18	2569
26.	178.9	3	19	2406
27.	191.0	3	18	2621
28.	197.4	3	16	2591
29.	198.0	3	18	2655
30.	205.1	3	17	2752

DISCUSSION.

It is well known that the nutrients taken in by the ixodid ticks are utilized for cuticle synthesis and other basic metabolic needs. It has also been shown, that there exists a linear relationship between the body weight and the number of eggs laid by a tick (OSWALD 1939, ASANUMA 1944, *a*, *b*, LOMBARDINI 1950, KITAOKA & YAJIMA 1958, ACHAN 1961, and SNOW & ARTHUR 1966).

The results obtained from the linear regression analysis between the body weight and the number of eggs indicate that when the body weight (W) in *Rhipicephalus sanguineus* is 5.52 the number of eggs laid becomes zero. In *Dermacentor variabilis*, however, the number of eggs never becomes zero. The equation also indicates that for every milligram increase in the body weight *R. sanguineus* and *D. variabilis* will respectively yield 14 (13.939) and 8 (7.733) eggs.

The ability of a tick to lay a certain number of eggs per milligram body weight-though " ultimate egg yield can not be ascribed to the quantity of nutrients imbibed by the adult female " (SNOW & ARTHUR, 1966) — appears to be a useful taxonomic feature.

It is suggested that the slope in the linear relationship between body weight and number of eggs produced by an adult tick be considered for this. Body size in ticks varies so does their blood imbibing capacity. Obviously their metabolic rates are different and this, probably, has a bearing on the rate of synthesis or production of egg material. The smaller the species the steeper the slope will be.

In support of the above contention a comparative statement of the " slopes " in some of the tick species are furnished :

Tick species	Slope in linear regression analysis (eggs/mg body wt.)	Author
1. *Rhipicephalus sanguineus*	13.939	NAGAR
2. *Boophilus caudatus*	11.9	KITAOKA & YAJIMA (1958)
3. *Haemaphysalis campanulata*	10.8	»
4. *H. bispinosa*	10.2	»
5. *Hyalomma anatolicum anatolicum*	9-10	SNOW and ARTHUR (1966)
6. *Dermacentor variabilis*	7.733	NAGAR

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Department of Biology
Dehli College, Delhi, India.

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