Nigerian J. Ent. (1983), 4, 1 — 11 DOI:10.36108/NJE/3891/40.0110

Parasitization of a Libellulid Dragonfly, *Urothemis assignata* Selys (Anisoptera : Libellulidae) by Water Mite Larvae of the Genus *Hydrachna* (Acarina: Hydrachnidae)

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(Accepted 13 March, 1980)

ABSTRACT

The parasitization of a libellulid dragonfly, *Urothemis assignata* Selys, by mite larvae of the genus *Hydrachna* is reported here for the first time. Infestation was initiated usually on the ultimate instar in water, although occasionally, the penultimate instar was infested. Parasitization of the adult host was evidenced by the presence of mites or their scar on the wings. Adults and larvae were parasitized all the year round, most heavily during the dry season (October to May). The number of the mite larvae per host varied between 12 and 206, while parasitism in the sample population ranged between 55 and 90%.

The transfer of mite larvae from the host larvae to adults during ecdysis seemed to coincide with the period of wing withdrawal from the cast skin. Mites re-entered water during territorial defence and mating of their adult hosts. There is evidence that the mite larvae develop into nymphochrysalis or nymphs before dropping into water.

Out of the other 10 common libellulids screened for mite parasitization, only three had mites. *Hygrobates* sp. was recorded on two of the three, whilst the third had *Hydrachna* sp.

INTRODUCTION

Water mite larvae are known ectoparasites of the imagines of aquatic insects. Smith & Oliver (1976) indicated that this ectoparasitic association is known in seven superfamilies of water mites within six orders of aquatic insects, of which the Odonata is one. Within the odonates, the larval mites of the family Arrenuridae are known to form an association with some libellulids and zygopterans (Mitchell, 1959, 1961), while Crowell (1963) indicated parasitization of damsel-flies by the family Limnocharidae. Apparently, the parasitization of odonates by mite larvae of the family Hydrachnidae has not been reported previously (see Smith & Oliver, 1976).

Penultimate and ultimate instars of dragonfly larvae are parasitized in water by these mite larvae from where they transfer to the emerging imagos during ecdysis. Mitchell (1961, 1969) elucidated the processes whereby the mite larvae locate and attach to their host larvae, migrate from the host larvae to the emerging imagines and also indicated the processes which stimulate such migration in mite larvae during ecdysis. The latter has to take place within a short span of time because of the short duration of ecdysis. The final attachment centres on the host are the abdomen (Mitchell, 1961) or the thorax, legs or abdomen (Mitchell, 1959; Efford, 1963; Corbet, 1963; Smith & Oliver, 1976).

U. assignata is a pond species. The larvae are perchers and live amongst submergent and emergent plants, *Pistia stratiotes* and *Azolla pinnata v. africana* being the most important, although *Marsilea diffusa, Salvinia nymphellula* and *Alternantheria sessilis* may also be used as substrates (Hassan, 1977). The adult libellulid flies all the year round in the humid tropics with the population and emergence of adults reaching a peak in the dry season (November-March/April) (Hassan, 1974).

METHODS

The population density of water mite larvae of the genus *Hydrachna* (Acarina: Hydrachnidae) on the penultimate and ultimate instars of *Urothemis assignata* Selys (Odonata: Libellulidae) and the emergent adults was studied at the Awba dam, Ibadan, Nigeria between October 1975 and Januarv 1977. The processes of transfer of the mite larvae from the ultimate instar to the imago of the host during ecdysis and of re-entering water by the mite larvae were observed both in the field and laboratory. Parasitism by *Hydrachna sp.* and *Hygrobates* sp. (Acarina: Hygrobatidae) on ten other species of libellulid adults which were common in this water system at the University of Ibadan, Nigeria was screened for, since Etta (1973) recorded the presence of these two water mite general at the Awba dam. The Awba dam, the field site, has already been described (Ita, 1971; Hassan, 1978).

Sampling for the population density of *Hydrachna* larvae on the penultimate and ultimate instars of *U. assignata* was carried out monthly at Awba dam between October 1975 and January 1977. The dragonfly larvae which were collected were examined for mite parasitization with a zoom binocular microscope, at a magnification of x40. The number of parasitized larvae, the number of attached mite larvae per individual and the site of their attachment were noted. The number of dragonfly larvae examined varied monthly, depending on their availability in the field, and ranged between 9 and 32 for both instars.

Likewise, a random sample of 20 adults (both males and females) of *U. assignata* was taken at forthnighlty intervals during the same period and examined for mite parasitization. These samples represented 10-21% of individuals at the collection sites. The number of individuals parasitized, the number of attached mite larvae per individual and the site of attachment were recorded.

The process of transfer of *Hydrachna* larvae from the host larvae to their imagines during ecdysis was observed in 36 individuals in the laboratory, whilst the process of re-entry of the mite larvae into water was observed in the field. In the laboratory, mite larvae were dislodged from their hosts, of varying ages, into crystalizing dishes (300.0cm3, 10.0cm diameter) in order to observe the duration of the development into the mobile nymphs.

Adults of ten libellulid species belonging to nine genera and five sub-families were screened at the Awba dam for parasitization by mite larvae. The numbers examined varied with the population density of each species.

RESULTS

Population density of larvae Hydrachna species

Results from the study on the population density of larvae of *Hydrachna* sp. on *U. assignata* are presented on Table 1. The penultimate instar was less parasitized than the ultimate instar. The percentage parasitization ranged from 0-16.1% in the penultimate instar and from 31.3—82.8% in the ultimate instar. The number of mite larvae per individual penultimate instar was also very low when compared with those on the ultimate instar. No parasitization was recorded on the former between April and August, 1976 and the largest number obtained on any individual was 6. On the ultimate instar, the numbers of mite larvae ranged from 3 to 61.

It thus appears that there is a seasonal fluctuation in both the proportion of host larvae parasitized and, particularly in the ultimate larvae, the number of mite larvae attached to each host. Statistical analyses using a 2 x 2 contingency table indicated significant differences between the dry and wet seasons in the level of parasitization of the ultimate larvae ($x^2 = 9.20$, d.f. = 1, $P<0.001$). Similarly, there were significant differences in the number of mite larvae parasitizing each ultimate instar larvae ($x^2 = 3.98$, d.f. = 1, $P<0.05$). Both the degree of parasitism and the number of mite larvae per ultimate instar were greater during the dry season (November - April) than in the wet season (April - October).

Table 1

Month	Penultimate (12th instar) larvae			Ultimate (13th instar) larvae		
	Number examined	% parasitism	No. of mite larvae per host larva	Number examined	% parasitism	No. of mite larvae per larva
Oct. 1975	24	14.3	4.0 (3—5)*	32	71.9	34.4 (16—48*
November	19	15.8	3.3 (2—5)	30	60.0	25.2 (21—37)
December	31	16.1	2.4 (2—3)	25	80.0	42.8 (14—61)
Jan. 1976	32	15.6	3.2 (1—6)	26	80.0	29.1 (8—50)
February	22	4.6	1.0 (1)	29	82.8	30.3 (11—39)
March	27	11.1	3.7 (3—5)	18	66.7	24.8 (16—32)
April	18	0.0	—	21	61.9	16.9 (8—30)
May	10	0.0	—	14	57.1	10.3 (5—18)
June	15	0.0	—	9	44.4	14.2 (6—21)
July	18	0.0	—	12	41.7	8.8 (3—15)
August	11	0.0	—	16	31.3	11.3 (3—24)
September	21	4.8	2.0 (2)	15	53.3	12.9 (4—21)
October	16	12.5	3.0 (1—5)	22	63.6	24.1 (18—32)
November	26	15.3	3.3 (2—4)	28	82.1	38.4 (15—56)
December	22	13.6	3.7(2—5)	19	52.6	30.7 (8—47)
Jan. 1977	20	15.0	2.0 (1—3)	27	72.4	27.4 (14—39)

*Figures in bracket show the range

In all the host larvae examined, mite larvae were located on the thoracic segments, particularly around the wing-buds.

The degree of parasitization of adult *U. assignata* was determined by totalling the number adults that had either mite larvae or mite larvae scars on their wings. In all, between 55% a 90% of the sampled adult populations were parasitized; 20% to 75% had mite larvae on t wings, whilst between 5% and 55% had mite larvae scars (Fig. 1). A 2 x 2 contingency tal showed that there was no significant difference between the seasons in the total parasitizati (x^2 = 0.28, d.f. = 1, P < 0.05). However, there were significant differences between t seasons in the incidence of mites on the wings (x^2 = 7.15, d.f. = 1, P < 0.001). Mite larvae wings were common during the dry and the early rainy seasons (November - May), whilst sc on wings were common during and towards the end of the rains (July — October) (Fig. 1 a Table 2).

The mean population density of mite larvae on the wings of the adults was variable t heavier than on the ultimate instar, ranging from 21.7 to 101.4 during the survey period (Ta 2). However, actual counts per sample varied widely. Although the mean number of mite lar per adult was low between July and early September (21.7—29.2), there was no significant c ference between the dry and wet seasons (x^2 = 0.068, d.f. = 1, P1, P < 0.05) There was als low but significant (P < 0.05) correlation between the parcentage of adults with mite larva the mean number of mite larvae encountered per adult during the period of study (r = 0.39 = 32).

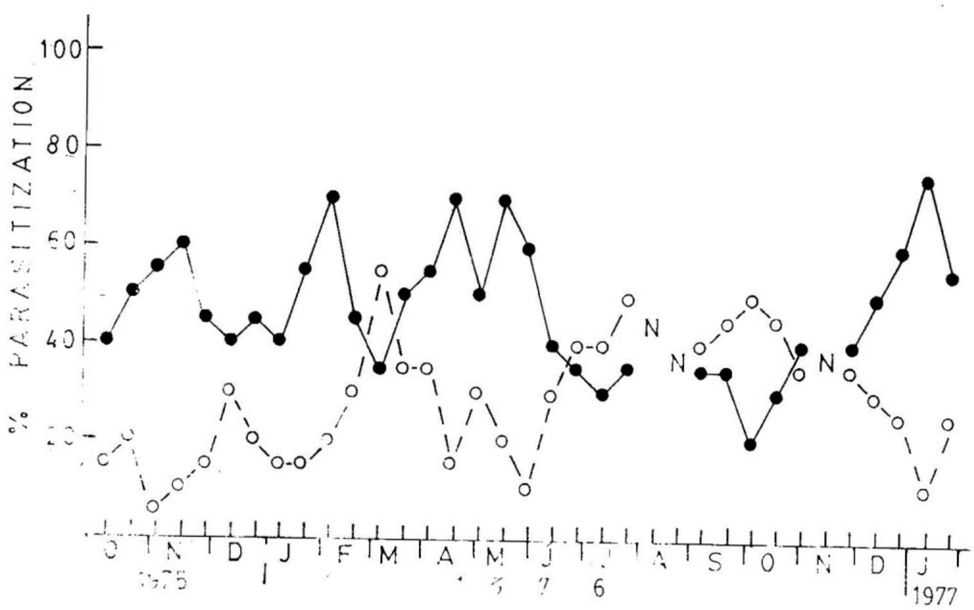


Fig. 1 -Fortnightly variations in the percentage of *Urothemis assignata* showing scars left on wings by mite larvae *(Hydrachna sp.)*

% with mite larvae %with mite larval scars N no population sampling

Transfer of mite larvae to adult host

The emerging adults of *U. assignata* were parasitized during ecdysis. The previously quiescent mite larvae became active during eclosion of the dragonfly imago and attached themselves to the bases of the wings as the dragonfly adult emerged from the cast skin. This probably explains why only the basal half of the wings up to the nodus was parasitized (Fig. 2a). In 36 observed cases, all the mite larvae successfully transferred to the imagines. The larvae generally lined up singly on the R1 vein, a major wing vein (Fig. 2b). However, there was generally some crowding of the mites at the nodus of the wings when parasitization was heavy (Fig. 2a).

Table 2 *Degree of parasitism and population density of* Hydrachna *species larvae on the wings of adult* Urothemis assignata *between October, 1975 and January, 1977.*

Month	%parasitism*	Number of mite larvae encountered per adult
October 1975	40.0	56.4 (19—124)**
	50.0	45.4 (18—115)
November	55.0	56.3 (8—124)
	60.0	44.8 (18—86)
	45.0	42.0 (18—69)
December	40.0	65.5 (36—141)
	45.0	38.1 (16—63)
January 1976	40.0	34.6 (16—68)
	55.0	36.6 (12—53)
February	70.0	43.5 (12—100)
	45.0	36.0 (16—72)
March	35.0	41.6 (18—71)
	50.0	52.4 (22—128)
April	55.0	93.5 (29—206)
	70.0	57.3 (18—146)
May	50.0	69.0 (26—148)
	70.0	67.9 (31—135)
	60.0	37.4 (15—112)
June	40.0	36.4 (14—76)
	35.0	37.3 (18—64)
July	30.0	29.2 (13—43)
	35.0	24.6 (15—41)
August	—	—
September	35.0	21.7 (12—33)
	35.0	51.3 (13—103)
October	20.0	58.0 (18—96)
	30.0	68.3 (23—173)
November	40.0	77.0 (43—126)
	—	—
	40.0	58.0 (25—123)
December	50.0	49.2 (16—81)
	60.0	75.4 (38—148)
January 1977	75.0	101.4 (41—175)
	55.0	100.3 (18—192)

* %of *U. assignata* with mite larvae on their wings (out of 20 per sample)

** Fingures in bracket show the range

—No sampling

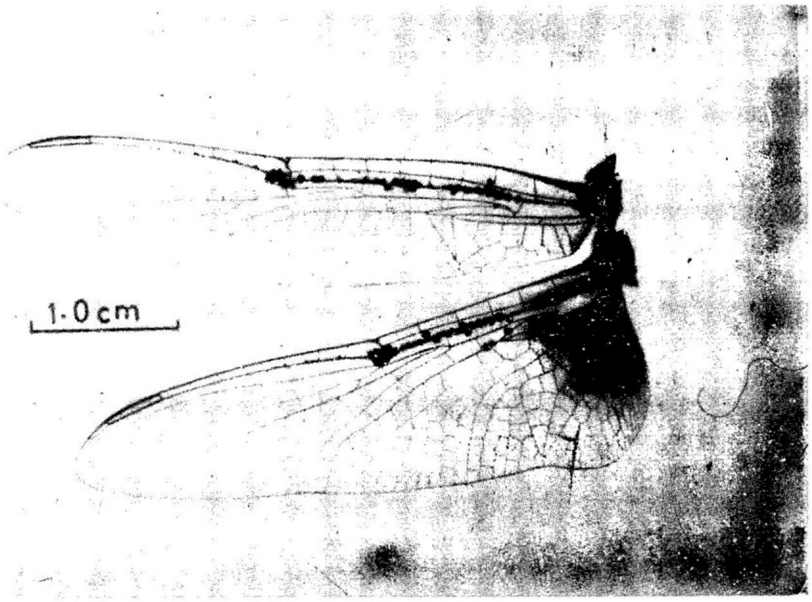
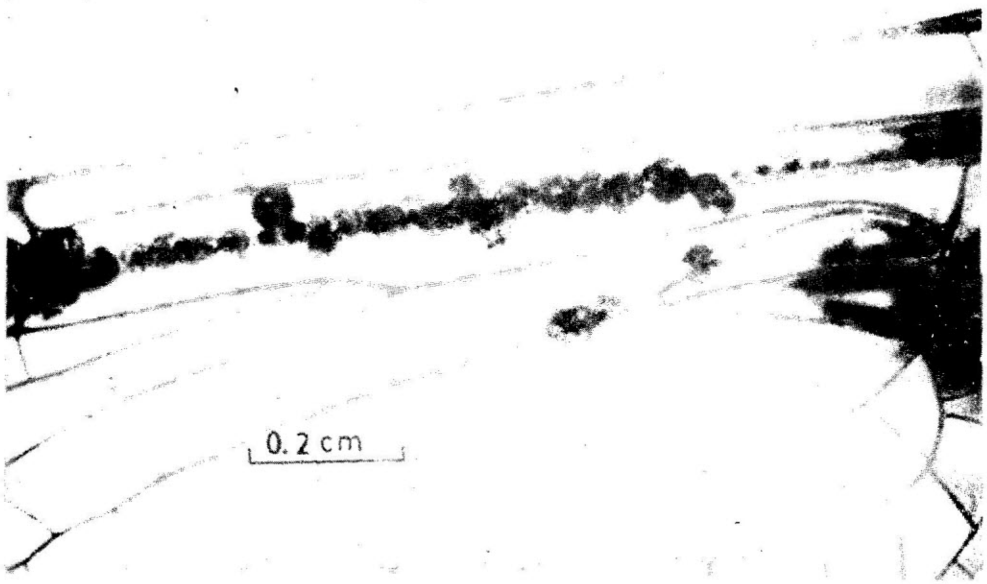


Fig. 2: (a) Distribution of mite larvae *(Hydrachna* sp.) on the wings of *Urothemis assignat*



(b) An enlarged basal half of the hind-wing of *Urothemis assignata* showing mite vae *(Hydrachna* sp.) distribution along the R1 vein.

Entry of mite back into water

The entry of mite larvae back into water occurs during periods of territorial clashes between males and during tandem oviposition by *U. assignata* copulae. Defence of territories involves wing clashes in the species (Hassan, upublished) while reproductive and tandem oviposition activities result in constant vibrations of the wings (Hassan, 1974). During these periods, mite larvae drop into water from the wings to complete their life cycle. The detachment of the mite larvae leaves scars on the wings of the dragonflies (Fig. 3a). Fig. 3b shows an enlarged part of the scars indicating the point of mite larvae attachment which are marked by the dark spots.

Laboratory studies on mite larvae dislodged into cystallizing dishes containing pond water revealed that the mite were usually not at the same stage of development, depending on the age of the dragonflies. Mite larvae dislodged from very young hosts (2 to 4 days old) floated in water and gradually matured into nymphs in about 9 to 15 days. Those dislodged from mature hosts (about 12 days or older) generally became active in less than 24 hours. The emerged nymphs were octopods and had well developed pedipalps. Their legs were typical of those of adult mites and they could swim in water.

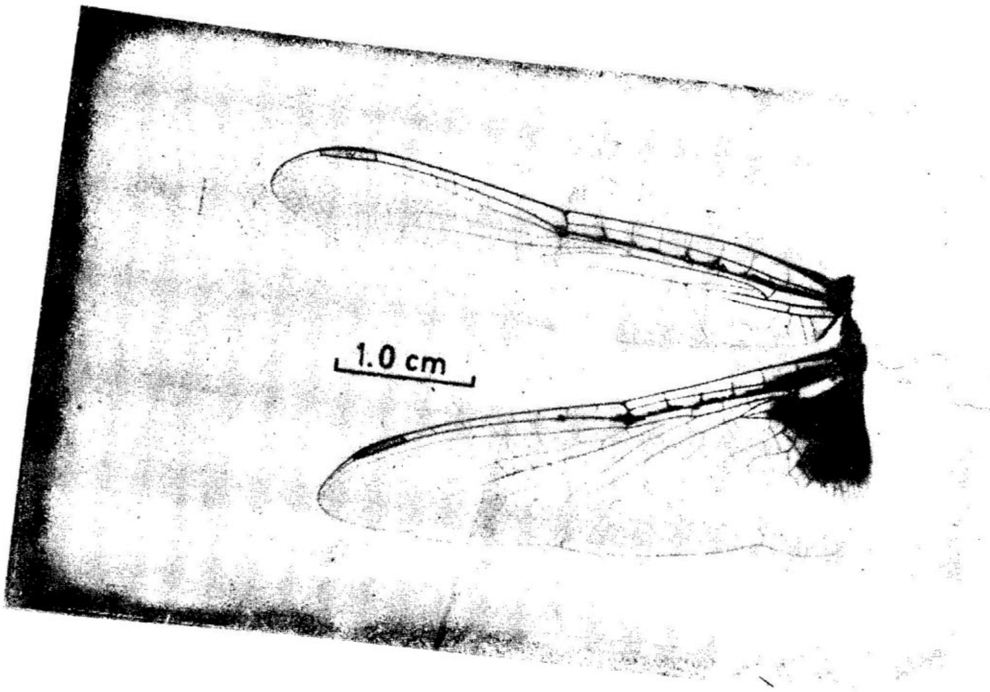
Mite parasitization in other libellulids

Only three of the ten species of libellulids screened for mite parasitization were parasitized - *Palpopleura lucia lucia* (Drury), *Urothemis edwardsi* Selys and *Aethriamanta rezia* (Kirby) (Table 3). *P. l. lucia* and *A. rezia* were parasitized by a hygrobatid mite, *Hygrobates* sp., whilst *U. edwardsi* was parasitized by *Hydrachna sp.* The degree of parasitization was very mild in *P. l. lucia;* only 2 of the 165 individuals screened were parasitized and the numbers of mite larvae per individual were 1 and 3. The number of mite larvae per *A. rezia* was also low 1 to 8)although 48 of the 226 individuals caught (21.2%) were parasitized. In *U. edwardsi* only 8 in-

Table 3 The incidence of mite larvae on ten species of libellulid dragonflies at Awba Dam between October, 1975 and January, 1977

Species	*Sub-family*	*Parasitization by mite larvae*	*Mite genus*	*Mite Population*
Orthetrum trinacria(Selys)	Tetratheminae	—		
Orthetrum austeni (Kirby)	,,	+		
Palpopleura lucia lucia (Drury)	Palpoleurinae	+		
Brachythemis leucostics (Burmeister)	Sympetrinae	—	**Hygrobates**	**1 — 3**
Acisoma panorpoides inflatum (Selys)	,,	—		
Crocothemis erythraea (Brulle)	,,	—		
Diplacodes lefebvrei (Rambur)	,,	—		
Urothemis edwardsi (Selys)	Macrodiplacinae	+		
Aethriamanta rezia (Kirby)	,,	-	Hydrachna	26—208
Pantala flavescens (Fabricius)	**Trameinae**	—	**Hygobates**	**1—8**

+ = parasitism — = no parasitism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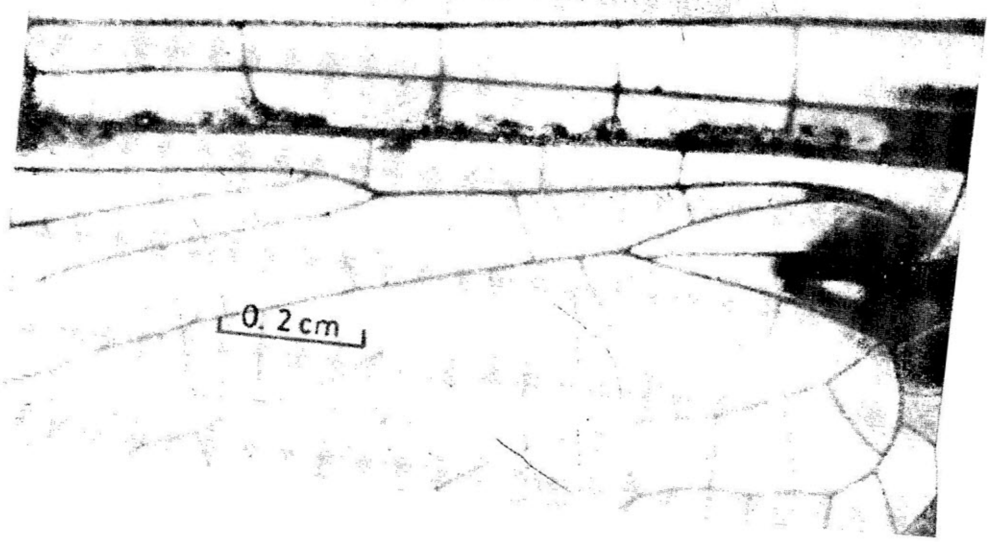
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dividuals were caught and 7 of them were parasitized. Parasitization was heavy, the number of mite larvae varying from 26 to 208 per dragonfly. In *P. l lucia* and *A. rezia,* the mite larvae were attached to the last three segments of the abdomen while in *(U. edwardsi* only the wings were parasitized.

DISCUSSION

In their review, Smith & Oliver (1976) stated that the mite family Hydrachnidae is mainly associated with Hemiptera and Coleoptera. In this study, a parasitic association between larvae of *Hydrachna* sp. and *U. assignata* is established. The association is initiated in water as is typical of the Hydrachnidae and mostly the ultimate instar is involved, although there is some evidence of the location of the aquatic host on the penultimate instar (Table 1). Very few mite larvae (between 1 and 6) were found on the parasitized penultimate instar while the density was high (3 to 61) on the ultimate instar. This difference in the mite larval load of the two instars conforms with the findings of Mitchell (1969) that mites prefer hosts which are close to ecdysis to immature larvae. Ellis-Adam & Davids (1970) also observed that mite larvae attacked only pupae of nematoceran hosts and not the larvae. On the other hand, Lanciani (1971) observed that all the five nymphal stages of a hemipteran host may be parasitized.

The site selection of the mite larvae during host ecdysis varies greatly between species (Münchberg, 1935) and this seems to be influenced by the way the larvae re-enter water, available nutrient and the relative protection offered from injury (Mitchell, 1959). Reported sites of attachment include the thorax, the legs and the abdomen (Mitchell, 1959; Corbet, 1963; Efford, 1963; Smith & Oliver, 1976). However, in the main species under study, the ventral surface of the wings is the site of attachment. The selection of one of the principal veins (R1) on the ventral surface of the wings seems to offer protection and probably provided nutrients to the mite larvae. The site also seems to offer the mite larvae a vantage position during entry back into water, since the wings are involved in territorial defence in the males (Hassan, 1974) and in balancing during in-tandem ovipositon. This view is supported by the large number of individuals taken in the field which had shed all their mite larvae (Fig. 1). This shows that the discharge mechanism here is different from those indicated by Mitchell (1959) and Davies (1959) in which the mite larvae are moistened at the time the female host is laying her eggs, and the mite larvae thereby become active and drop back into water.

The regularity of positioning on the wings of their host observed in the mite larvae (vide Fig. 2a and 2b) suggests a kind of site recognition and specificity. However, Mitchell (1961, 1967) indicated that there is no site recognition by the mites since they tend to attach to the first ventral membrane they encounter. He stated further that site specificity might result from the regularity of the time of transfer of the mites. This site specificity may, however, have a bearing on the response of mite larvae during host ecdysis.

Excessive mite load resulting in death was not observed in this study as was indicated by Mitchell (1969). Neither damage to the wings nor any noticeable effect on flight as a result of the mite larval loads in the hosts was observed. This is probably due to the fact that the R^1 vein is the fold axis of the wing, and is aerodynamically safe for the insect.

Laboratory observations on mite larvae disclodged from the wings of *U. assignata* of various ages suggest that some degree of development takes place during the attachment of larvae to their host, since they do not all become active nymphs at the same time. The 9 to 15 days required by the mite larvae disclodged from imagines to develop into nymphs indicated the duration of the nymphochrysalis. However, once the nymph emerges, it swims freely in water. This development of the water mite larvae into nymphs before detachment has been descri typical of the mites of the family Hydrachnidae by Mitchell (1957).

The duration of mite larval development into nymphs on the host is approximately th period it takes its host's gonods to mature. This suggests a synchronized timing of develc of the mite larvae with the maturation period of the host when they begin to visit wa final habitat of the mites. Hence, all hosts with discharged mite scars as in Fig. 3a an parous females and males.

Of the five libellulid sub-families screened for mite parasitization, only the Macrodip were parasitized, with the exception of *P. lucia lucia,* a palpoplurine. Sites selected hydrachnids were on the ventral side of the wings, while the hygrobatids preferred dominal segments. All parasitizations by *Hydrachna* sp. were heavy, while those by *Hyg* were light. This is probably because the population of *Hygrobates* in the pond was le 15% of that of the *Hydrachna,* and *Hygrobates* has also been observed on other aquati including hemipterans (Etta, 1973), and mosquitoes (Hassan, unpublished). Howeve makes members of the sub-family Macrodiplacinae the most favourable hosts for mit particularly of the genus *Hydrachna* at the Awba dam, requires further investigation.

ACKNOWLEDGEMENTS

I am indebted to R.M. Gambles Esq. of Windings England for the identificatio dragonflies and their classification and to Mrs E.E. Etta of the Department of B Sciences, University of Port Harcourt for the identification of the water mites.

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