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**A BIOLOGICAL STUDY OF SCALE INSECTS ON
CHALK GRASSLAND.**

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Faculty of Biological Sciences for
the Degree of Doctor of Philosophy.

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ABSTRACT

Five species of grass-infesting scale insects, representing five genera and three families were collected at Rough Common, Wytham Wood, Berkshire, and the biology of two of them (Greenisca placida and Eriopeltis sp.) was studied:

Family - Coccidae

Subfamily - Filippinae

I. Genus Eriopeltis Signoret, 1872.

1. Eriopeltis sp.

II. Genus Parafairmairia Cockerell, 1899.

2. Parafairmairia gracilis Green, 1916

Family - Eriococcidae

III. Genus Greenisca Borchsenius, 1948.

3. Greenisca placida (Green, 1921)

IV. Genus Rhizococcus Signoret, 1875.

4. Rhizococcus pseudinsignis (Green, 1921)

Family - Pseudococcidae

V. Genus Dysmicoccus Ferris, 1950.

5: Dysmicoccus walkeri (Newstead, 1891)

In all the cases, except Parafairmairia gracilis, the favourite food plant was found to be Brachypodium pinnatum (L.) Beauv.. Both Greenisca and Eriopeltis were found to be host-plant specific from laboratory experiments. No experiments were carried out to determine the food plants of either. Rhizococcus or Dysmicoccus. However, at Wytham, both have also been observed on Agrostis sp., and the latter occasionally on

Nardus stricta and Zerna (Bromus) erecta Huds. as well. The hosts of Parafairmairia gracilis were determined (by Dr. Wells) to be Carex flacca Schreb. and Zerna erecta Huds..

Detailed studies were carried out on Greenisca placida (Green) and Eriopeltis sp.. Greenisca placida (Green, 1921) was recorded from Britain and USSR (Leningrad) only, and was first reported and described by Green, as Eriococcus placidus Green, (1921). The species of Eriopeltis that occurred at Wytham, is different from the other two species known to occur in Britain. Eriopeltis festucae (Fonse., 1834) on Festuca is on the British list and the other species known at present as Species A (on Agrostis at Silwood Park) and Eriopeltis sp. on Brachypodium pinnatum from Wytham, are new to Britain.

Data on the life histories of both Greenisca and Eriopeltis on Brachypodium pinnatum, at Wytham, showed that in this wood each of them has only one generation a year, consisting of four stages in the female, namely, egg, two nymphal instars and the adult, but six stages in the male: egg, two nymphal, one prepupal, one pupal and the adult male. The egg stage lasts from August to May; first instar from mid May to mid June; second instar from early June to late July and the adult females from late July to late September. Apparently, Eriopeltis eggs hatch about a week later than those of Greenisca and its life cycle is of longer duration. All the stages of the female Greenisca including the adult before the secretion of its ovisac are mobile whereas in the case of Eriopeltis all the

stages except the crawler (early first instar nymph) are unable to move. Males of both species emerge from mid July to early August and have a very short life of 1-4 days.

Morphological characters of each stage were studied. Detailed descriptions and figures for each stage of the two species (on Brachypodium pinnatum) are presented. The adult female Greenisca placida is redescribed and briefly compared with Greenisca inermis (Green, 1916) on Deschampsia flexuosa. The males of both Greenisca and Eriopeltis belong to the 'lecanoid type' and the description of the male of the genus Greenisca is given for the first time.

At Wytham, in 1969, female Eriopeltis commenced oviposition in the second week of September, by which time Greenisca had already finished laying their eggs and shrivelled up. Eriopeltis females being about four times the size of Greenisca females usually produced four times as many eggs or more. When both species were bred in the greenhouse it was found that Greenisca could tolerate greenhouse temperatures (about 26°C) and reproduce whereas adult female Eriopeltis could not do so. Perhaps the higher temperatures did have an injurious effect on the reproductive system of female Eriopeltis.

Although males were very rare in the field the sex ratio was found to be 3♀: 2♂ for Greenisca (by laboratory experiments). In the laboratory, males and females occurred in equal proportions in Eriopeltis, with a tendency for more males to occur when warm and dry conditions prevailed during

development.

Crawlers of both Greenisca and Eriopeltis were found to move away from direct and bright light. This may account for the crowded occurrence of adult females of both the species on the basal third to half of the grass blades. Their preference of a more basal position may be due to three reasons: firstly, to protect themselves from being dislodged and blown away by the wind, especially during the crawler stage when they are vigorously searching for a suitable host (food) plant; secondly, to avoid direct bright light, as mentioned earlier, and higher temperatures during the summer; thirdly, to get the maximum amount of food and protection, as the grass usually starts browning and drying off from the tip downwards.

Dispersion by emigration, wind and animals can occur at any stage of the life cycle in Greenisca, but not after the ovisac has been secreted, unless ^{passively} mechanically transported. In Eriopeltis natural dispersion can occur only during the crawler stage, the other instars having lost their powers of movement.

Both Greenisca and Eriopeltis were seen to be attacked by a number of chalcid parasites. Trichomasthus frontalis Alam, was the most important but it was in turn attacked by a Pteromalid, Pachyneuron concolor Förster which was equally abundant. The other entomophagous parasites of Greenisca included Microterys zarina (Walker), Metaphycus piceus Hoffer, Protyndarichus comara (Walker) and Rhopus (Rhopus) piso (Walker). Eusemion cornigerum (Walker) was a hyperparasite of Greenisca placida.

Metaphycus zebratus Mercet, Subprionomitus cantabricus Mercet and Cerapterocerius mirabilis Westwood were bred from parasitised material of Eriopeltis out of which C. mirabilis was a hyperparasite. Eunotus cretaceus Walker is an egg predator which was seen to be closely tied ecologically to Eriopeltis sp. at Wytham, not attacking other species of scale insects.

Cheiloneurus paralia (Walker) was bred from both Eriopeltis sp. and Greenisca. The Chamaemyiid fly, Leucopis silesiaca Egger was an egg predator of both these scale insects at Wytham. None of the parasites were seen to attack the male instars and the first nymphal instar. The parasite larvae, specially those of Pachyneuron suffered a very high mortality in the field during winter. The mean percentage parasitism tended to increase from 1968 to 1970 (1968- 7.2%; 1969- 15.6%; 1970- 29%). Out of the parasitised females of Greenisca the majority deposited approximately half their full complement of eggs, so that the mean number of eggs laid by a parasitised Greenisca was eleven.

The period in which suitable Greenisca were available to the parasites was 2-3 weeks. Although parasites were available in the field during this period they did not appear to respond to the presence of Greenisca but to the period when Eriopeltis had been available in the same locality in the past few years, about two weeks later than Greenisca. Judging by Prof. Varley's field collections at Rough Common, Wytham, from 1964 onwards, there had been a heavy infestation of B. pinnatum by Eriopeltis which by 1969 had been drastically reduced in numbers, probably

due to the action of parasites and predators which later moved on to Greenisca.

Two species of Chalcidoid parasites, both Encyrtids, were reared from Dysmicoccus walkeri, namely, Leptomastix epona (Walker), and Anagyrus sp.. No parasites were reared from Parafairmairia gracilis collected at Wytham.

The pedicellate nature of the egg furnishes during the early stages of parasitization, the sign of difference between a parasitised and an unparasitised host. During later stages the parasitised host appears hard compared to the soft-bodied unparasitised scale.

Two life tables were prepared for Greenisca placida for 1968 and 1969 generations respectively. The various mortalities suffered by Greenisca at various stages of its life history were studied by regular sampling, in an attempt to study the mortality factors affecting the various stages of its life cycle and to correlate the different mortalities with the adult density per unit area.

The reduction in natality was considerable but egg mortality was generally low. The nymphal mortality due to overcrowding was the highest. An insignificant mortality was caused by Coccinella septempunctata. Fungus attack was the cause of death of some nymphs and adults. Adult mortality was mainly due to host feeding, parasitism and predation and in a few cases the cause of death was unknown. Laboratory experiments showed, that the nymphal mortality is density dependent.

2. <u>Greenisca</u> sp. from <u>CONTENTS</u>	39 - 55
Identity of <u>Greenisca</u> sp. from Wytham	Page 40
<u>ABSTRACT</u>	1 - vi
1) <u>AIMS AND METHODS OF STUDY</u>	1 - 10
Introduction	1 42
Study area	2 50
Materials	4 55
Preparation of specimens for study	6 31
Illustrations	8 51
2) <u>DESCRIPTION OF SPECIES</u>	11 - 55
1. <u>Greenisca placida</u> (Green, 1921)	11 - 30
Distribution and records	11 24
Material examined	11 55
Adult female	12 90
Ovisae	16 73
Adult males of Eriococcidae	17 55
Adult male of <u>Greenisca placida</u> (Green)	18 55
Description of stages	24 - 30
Egg	24 59
Immature stages	25 63
First instar nymph development	25 64
Second instar nymph emergence of males	27 64
Prepupa	29 65
Pupa	29 65
Female reproductive activities	66
Distribution of <u>Greenisca placida</u> females on its host	68
Host relations	71

2. <u>Eriopeltis</u> sp. from Wytham	30 - 55
Identity of <u>Eriopeltis</u> sp. from Wytham	30
Adult female	35
Ovisac	41
Adult male <u>Eriopeltis</u> sp.	42
Male puparium	50
Description of stages	51 - 55
Egg	51
First instar nymph	51
Second instar female nymph	52
Second instar male nymph	53
Prepupa	54
Pupa	55
3) <u>BIOLOGY OF SPECIES</u>	55 - 90
1. <u>Greenisca placida</u> (Green, 1921)	55 - 72
Eggs	55
Hatching and emergence	55
Diapause	56
First instar nymph	59
Second instar nymph	63
Prepupal and pupal development	64
Longevity and daily emergence of males	64
Sex ratio	65
Behaviour of male after emergence	65
Female reproductive activities	66
Distribution of <u>Greenisca</u> females on its host	68
Host relations	71

2. <u>Eriopeltis</u> sp. from Wytham	72 - 81
Eggs	72
Hatching and emergence	73
Diapause	73
First instar nymph	74
Second instar nymph	76
Prepupal and pupal development	77
Longevity and daily emergence of males	78
Sex ratio	78
Behaviour of male after emergence	79
Female reproductive activities	80
Sex attractant in females of <u>Coccoidea</u>	81
Sense ecology	82
Phytophagic varieties	84
Mode of dispersal	85
Arrival at Wytham	86
3. <u>Parafairmairia gracilis</u> Green, 1916	87
4. <u>Rhizococcus</u> sp. (<u>insignis</u> Newst. or <u>pseudinsignis</u> Green)	89
5. <u>Dysmicoccus walkeri</u> (Newst.)	89
4) <u>ON THE PARASITES AND PREDATORS OF GREENISCA</u> <u>AND ERIOPELTIS</u>	91 - 109
Introduction	91
Parasite and predator list of <u>Greenisca placida</u>	91
Parasite and predator list of <u>Eriopeltis</u> sp.	92
Short notes on each of the parasites and predators	92
<u>Trichomasthus frontalis</u> Alam	93

<u>Microterys zarina</u> (Walker)	94
<u>Metaphycus ?piceus</u> Hoffer	94
<u>Protyndarichus comara</u> (Walker)	95
<u>Rhopus ?piso</u> (Walker)	95
<u>Metaphycus zebratus</u> Mercet	95
<u>Subprionomitus cantabricus</u> Mercet	96
<u>Cheiloneurus paralia</u> (Walker)	96
<u>Cerapterocerus mirabilis</u> Westwood	97
<u>Eusemion cornigerum</u> (Walker)	98
<u>Pachyneuron concolor</u> Förster	99
<u>Eunotus cretaceus</u> Walker	100
<u>Leucopis silesiaca</u> Egger	101
<u>Coccinella septempunctata</u> L.	106
<u>Chrysopa carnea</u> Stephen	107
Discussion	107

5) <u>DEVELOPMENT OF TRICHOMASTHUS FRONTALIS ALAM. AND ITS BEHAVIOUR IN RELATION TO ITS HOST, GREENISCA</u>	110-118
Introduction	110
Ovarian egg	110
Deposited egg	111
Developmental stages	111
Distinguishing features of the parasitised host	113
Effect of parasite on the host	114
Effect of host on parasite success	115
Behaviour and site of oviposition of the parasite	116
<u>Pachyneuron concolor</u> in relation to <u>Trichomasthus</u> and <u>Greenisca</u>	117

6)	<u>POPULATION STUDIES ON GREENISCA PLACIDA (GREEN)</u>	119 - 131
	Materials and methods	119
	Method of analysis of samples	120
	Life tables	121
	Analysis of field data	122
	Construction of a budget for <u>Greenisca placida</u>	122
	Mortality factors affecting <u>Greenisca placida</u>	125
	Behavioural response of <u>Trichomasthus</u> towards <u>Greenisca</u>	128
7)	<u>DISCUSSION</u>	132 - 136
8)	<u>ACKNOWLEDGEMENTS</u>	137
9)	<u>REFERENCES</u>	138 - 146

Family - Eriopodidae

III. Genus Greenisca Berghsenius, 1948.

3. Greenisca placida (Green, 1921)

IV. Genus Rhizococcus Signoret, 1875.

4. Rhizococcus pseudoplacida (Green, 1921)

Family - Lysiplococcidae

V. Genus Lysiplococcus Ferris, 1950.

5. Lysiplococcus walkeri (Newstead, 1914)

In all the cases, except Parafairairia gracilis, the favourite food plant was found to be Brachypodium pinnatum (L.) Beauv. Both Greenisca and Rhizococcus were found to be host-plant specific from laboratory experiments. No experiments were carried out to determine the food plants of either Rhizococcus or Lysiplococcus. However, at times, both have also been observed on Agrostis sp., and the latter occasionally on