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STUDY OF THE FEEDING HABITS OF MALE
ANOPHELES SERGENTII THEO. AT SIWA
OASIS USING RADIOPHOSPHORUS¹

by

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Synopsis

Little has been published on the feeding habits of male mosquitos, and the subject has not previously been investigated in respect of the important oasis malaria vector, Anopheles sergenti. Of 40 different plant species labelled with P^{32} in a field laboratory at Siwa, only three (Salicornia fruticosa, Alhagi maurorum and Juncus arabicus) proved to be utilized for feeding purposes when exposed to A. sergenti males. These three grow wild in different parts of Siwa, in and around the seepages and drainage canals from springs serving as larval habitats for this anopheline. Male A. sergenti were subsequently collected from them in the field in much greater numbers than from other plants. They comprise a relatively small proportion of the local flora, and should further studies prove the males of this anopheline unable to adjust to alternative food sources, it is submitted that their selective control could be of practical vector control significance - for example, in lowering the normal ratio of A. sergenti males to females immediately prior to the mass release of males sterilized by means of chemosterilants or radioisotopes.

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Introduction

The development of resistance to insecticides by numerous species of mosquitos has focused attention on the need for supplementary and alternative control procedures. Assessments are thus now being made of the potentialities of various types of ecological control, and in this connexion a need has been felt for more specific information in the neglected area of the feeding habits of male mosquitos in nature.

Specificity of plant feeding having recently been demonstrated for the males of four species of Aedes in Canada (Abdel-Malek & Baldwin, 1961), the present WHO-sponsored study was designed to investigate the suitability of the various plants of an ecologically isolated habitat as food for male Anopheles sergenti Theo., and the natural feeding habits of these insects. The project was undertaken at Siwa Oasis, from 19 May to 28 June 1963.

General description of the study area

Siwa is about 600 km north-west of Cairo, on the Libyan Plateau (latitude $29^{\circ}05' - 29^{\circ}15'N$, longitude $25^{\circ}15' - 25^{\circ}45'E$). The oasis has a human population of about 4500. It lies about 22 m below sea level, has a total area of about 200 km², and consists of five sections: Maraki, Khamisa, Siwa, Agormi and Zeitoun. Its water-table is high, the supply being drawn from springs and wells. There are about 240 of these water sources, their average dimensions being 3-10 m in diameter and 10-20 m in depth, and many seepages exist too. The salinity of the water ranges from 16-20 g/l, and the hydrogen-ion content from pH 6-7. Only about 800 hectares are under cultivation, the main crops (dates, olives, barley and some vegetables and fruits) being grown in gardens around the springs.

Materials and methods

Male A. sergenti needed for experimental purposes were reared in a field laboratory from larvae brought in from the field. Drainage canals from the springs, and seepages, proved to be the most favoured larval habitats, A. sergenti sharing these with other anophelines and culicines too.

After being identified at the laboratory, the larvae were placed in white enamel basins 32 cm in diameter and 10 cm deep. About 200 larvae were reared in each basin in a litre of tap water. Powdered dog biscuits and a commercial yeast preparation served as food for the larvae. The rearing basins were protected with white muslin covers measuring 40 x 40 cm, each having 12 small lead weights stitched around its periphery in order to keep it in place over the basin concerned. By this means, muscoid flies, which were present in great numbers in the laboratory and elsewhere, were prevented from entering the rearing basins and contaminating the medium. As soon as the larvae metamorphosed to pupae, the latter were transferred to 250-ml beakers with 100 ml of tap water. The beakers were then placed inside an emergence cage (60 x 40 x 50 cm) having a glass top, sides of metal screening, and a circular front opening 15 cm in diameter with a muslin sleeve. Dextrose solution (10%) served as food for the mosquito adults emerging inside the cage. The medium was supplied soaked into absorbent cotton covered with a piece of lint, in a Petri dish.

The different plants present in and around the larval habitats of A. sergenti (Table 1) were collected and brought to the laboratory for experimental purposes. They were cut in the field under water, their ends being kept immersed until used for the experiments. In the laboratory, the cut end of a stem from each plant (carrying leaves, and flowers where present) was wrapped in a piece of cotton and immersed in 30 ml of 20 microcuries per ml of radiophosphorus ($\text{Na H}_2\text{P}^{32}\text{O}_4$) in distilled water inside a 50-ml wide-mouthed bottle. The opening of the bottle was then covered with cheese cloth to prevent the mosquitos from coming into direct contact with the radio-active solution. Every plant exposed to radiophosphorus was set aside for 24 hours before being placed inside an experimental cage measuring 25 x 25 x 50 cm, having the top and sides of metal screening, and a sliding glass front. Without exception, the leaves and flowers of the plants took up appreciable amounts of radio-activity. In some species, about 30 000 counts per minute per cm^2 of leaf or flower were registered.

Fifteen A. sergenti males aspirated from the emergence cage were introduced into the experimental cage through a 5-cm opening in the centre of the glass front, which was then closed with a cork. The males were left for 48 hours with the radio-active plant. After that exposure time, all the mosquitos inside the cage were taken out, killed, if still alive, by chloroform vapour, and washed in three changes of distilled water. After being dried between two pieces of filter-paper, each was transferred by means of clean pointed forceps to the centre of a thin rounded copper planchet 2.5 cm in diameter, and was then covered with a piece of cellotape. The mosquitos on the planchets were now assayed for their radio-activity.

Counts of radio-activity were made with a Geiger-Müller end-window tube (2 mg/cm^2) and a United Arab Republic scaler. All counts were corrected for background and decay of radiophosphorus. Correction for self-absorption was not made because of the thinness of the mosquito bodies.

The laboratory temperature was $30^{\circ}\text{C} \pm 2^{\circ}$, relative humidity averaging 35%. In order to guard against the death from dehydration of the caged adult mosquitos, the emergence and experimental cages were wrapped with face towels which were soaked with water at least five times a day. This procedure built up the relative humidity inside the cages to $90 \pm 5\%$, as measured by means of pocket hair hygrometers kept within them. The laboratory temperature was recorded by means of a maximum and minimum thermometer.

Every plant experimented on was given a code number, and a portion of it was placed in a press for future identification.

Results and discussion

Forty different species of plants both wild and cultivated, belonging to 24 families and representing almost every species encountered in the oasis, were experimented on for their suitability as food for the males of A. sergenti.

The results of these experiments are shown in Table 1, from which it is apparent that out of the 40 species of plants investigated, only three proved suitable as food for A. sergenti males. These plants, in descending order of their importance in this respect, were:

Salicornia fruticosa (L.) L.

Alhagi maurorum Medic.

Juncus arabicus (Asch. et Buch.) Adams.

It was also observed that feeding took place on both flowers and leaves and lasted 10 minutes on the average.

Having reached this result from the laboratory experiments, attention was transferred to the distribution of the plants in the oasis. All three species were found to be widely distributed. They were especially abundant in and around the breeding sites of A. sergenti. It is interesting to note here that after an intensive survey of 113 different springs, drainage canals, seepages and ponds, we came to the conclusion that finding Salicornia fruticosa and/or Juncus arabicus in or around any of these waters was sufficient indication that A. sergenti was breeding there.

In the interests of determining the natural food preferences of A. sergenti males, adult mosquitos were now collected from the various plant species in the oasis. Males of A. sergenti were taken in good numbers from the three species already named, Salicornia fruticosa, Alhagi maurorum and Juncus arabicus (50, 36 and 20 males respectively). Very few were collected from any of the other plants, two of which (Olea europaea and Vitis vinifera) yielded only two males each.

In our search for adult anophelines at Siwa, A. sergenti males were also found resting in the thatched roofs of houses and stables, especially those near the larval habitats, and inside the caves present in some of the hills near Siwa township (Mountain of the Dead), Dacrour and Agormi.

Practical application of the knowledge of the specificity of plant feeding on the part of A. sergenti males could favour the success of novel control procedures. For example, the elimination of Salicornia fruticosa, Alhagi maurorum and Juncus arabicus (which comprise a relatively minor proportion of the flora of Siwa Oasis) might provide a means of sharply reducing the numbers of males in the natural A. sergenti population prior to an eradication attempt involving the release of large numbers of males sterilized by means of chemicals or radio-active isotopes. First, however, a field trial would be called for to determine whether, in the absence of these three plants, A. sergenti males are able to adapt to alternative natural food sources.

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REFERENCE

Abdel-Malek, A. A. & Baldwin, W. F. (1961) Specificity of plant feeding in mosquitoes as determined by radioactive phosphorus, Nature, 192, 178-179

TABLE 1. RADIO-ACTIVITY OF ANOPHELES SERGENTI MALES
 EXPOSED FOR 48 HOURS TO 40 RADIO-ACTIVE PLANTS

Name of plant	Family	Average radio-count of mosquitos, above background
<u>Alhagi maurorum</u> Medic.	Leguminosae	145 counts per minute
<u>Beta vulgaris</u> L. var. <u>cicla</u> L.	Chenopodiaceae	0 " " "
<u>Centaureum pulchellum</u> (Sw.) Druce	Gentianaceae	0 " " "
<u>Ceratonia siliqua</u> L.	Leguminosae	0 " " "
<u>Citrus aurantifolia</u> Swingle	Rutaceae	0 " " "
<u>Citrus limon</u> Burm. f.	Rutaceae	0 " " "
<u>Citrus reticulata</u> Blanco	Rutaceae	0 " " "
<u>Conchorus olitorius</u> L.	Tiliaceae	0 " " "
<u>Cucumis sativus</u> L.	Cucurbitaceae	0 " " "
<u>Cucurbita pepo</u> L.	Cucurbitaceae	0 " " "
<u>Eucalyptus camaldulensis</u> Dehnh.	Myrtaceae	0 " " "
<u>Ficus carica</u> L.	Moraceae	0 " " "
<u>Flaveria contrayerba</u> (Cav.) Pers.	Compositae	0 " " "
<u>Glycyrrhiza glabra</u> L.	Leguminosae	0 " " "
<u>Juncus arabicus</u> (Asch. et Buch.) Adams	Juncaceae	47 " " "
<u>Lawsonia intermis</u> L.	Lythraceae	0 " " "
<u>Lycopersicum esculentum</u> Mill.	Solanaceae	0 " " "
<u>Malus salivestris</u> Mill.	Rosaceae	0 " " "
<u>Medicago sativa</u> L.	Leguminosae	0 " " "
<u>Mentha spicata</u> L.	Labiatae	0 " " "
<u>Morus alba</u> L.	Moraceae	0 " " "
<u>Nitraria retusa</u> (Forsk.) Asch.	Zygophyllaceae	0 " " "
<u>Olea europeae</u> L.	Oleaceae	0 " " "
<u>Phoenix dactylifera</u> L.	Palmaceae	0 " " "
<u>Polypogon monspeliensis</u> (L.) Desf.	Graminae	0 " " "

TABLE 1. RADIO-ACTIVITY OF ANOPHELES SERGENTI MALES
 EXPOSED FOR 48 HOURS TO 40 RADIO-ACTIVE PLANTS (continued)

Name of plant	Family	Average radio-count of mosquitos, above background
<u>Portulaca oleraceae</u> L.	Portulacaceae	0 counts per minute
<u>Prunus amygdalus</u> Basch	Rosaceae	0 " " "
<u>Prunus armeniaca</u> L.	Rosaceae	0 " " "
<u>Prunus domestica</u> L.	Rosaceae	0 " " "
<u>Prunus persica</u> Batsch	Rosaceae	0 " " "
<u>Psidium guajava</u> L.	Myrtaceae	0 " " "
<u>Punica granatum</u> L.	Punicaceae	0 " " "
<u>Pyrus communis</u> L.	Rosaceae	0 " " "
<u>Rosa</u> sp.	Rosaceae	0 " " "
<u>Salicornia fruticosa</u> (L.) L.	Chenopodiaceae	324 " " "
<u>Scirpus litoralis</u> Schrad.	Cyperaceae	0 " " "
<u>Tamarix nilotica</u> (Ehrenb.) Bge.	Tamaricaceae	0 " " "
<u>Vitis vinifera</u> L.	Vitaceae	0 " " "
<u>Ziziphus spina-christi</u> (L.) Willd.	Rhamnaceae	0 " " "
<u>Zygophyllum coccineum</u> L.	Zygophyllaceae	0 " " "

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