Table 2. Cumulative percent of exiting *Anopheles albimanus* collected hourly from the curtain in houses sprayed with bendiocarb.

	Hour											
Treatment and month	1900	2100	2300	0100	0300	0500	2000	2200	2400	0200	0400	0600
Prespray	5.3	39.1	78.2	86.2	95.5	100.0	5.1	21.2	41.4	63.3	80.8	100.0
Postspray (Aug.–Sept.)	10.9	39.0	61.4	85.0	95.4	100.0	4.1	26.2	52.4	72.5	85.6	100.0
Postspray (Oct.)	14.6	50.8	82.0	92.8	97.7	100.0	7.8	37.2	68.1	86.8	94.8	100.0
Postspray (Nov.)	11.1	57.8	72.2	79.9	96.6	100.0	1.7	23.7	44.0	60.9	79.5	100.0

Table 3. Percent mortality of *Anopheles albimanus* collected from the curtain in houses sprayed with bendiocarb.

Treatment and month	Fed	Unfed
Prespray	0	0
Postspray (Aug.–Sept.)	82	98
Postspray (Oct.)	60	95
Postspray (Nov.)	63	83

than 70%, 2.5 months postspray (Table 3). Unfed mosquitoes were found to have a higher mortality than fed mosquitoes indicating that they have a higher susceptibility to insecticide intoxication or rested longer on treated surfaces than fed mosquitoes.

The use of the curtain trap as it is described can be extended to the study of other aspects of mosquito behavior. This could include using engorged mosquitoes resting on the exterior of the curtain for bloodmeal analysis. In addition, mosquitoes could be analysed to determine parasite infection rates as related to epidemological studies.

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FIRST RECORD OF MALARIA AND ASSOCIATED *ANOPHELES* IN EL GARA OASIS, EGYPT[1]

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Oasis malaria is an epidemiologically unique form of this disease since it usually occurs in isolated populations living under extreme conditions. Historically, the five major Egyptian oases were endemic for malaria, including *Plasmodium vivax*, *P. falciparum* and *P. malariae* (Halawany and Shawarby 1957). Early surveys by Barber and Rice (1937) showed that *Anopheles sergentii* (Theobald) was likely the major oasis malaria vector, as in other oases throughout the Middle East (Farid 1956). Although *An. sergentii* from the Egyptian oases has never been found infected with sporozoites, control programs focusing on this species in Siwa Oasis substantially reduced malaria prevalence from 19% to less than 1% (Halawany and Shawarby 1957). Malaria, primarily *P. vivax*, persists at a low rate in Siwa Oasis, but there have been no recent reports of malaria from the other major oases.

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During studies in April 1983 to evaluate the present malaria situation in Siwa Oasis, a trip was made to El Gara, a small oasis 120 km northeast of Siwa located near the southwestern edge of the Quttara Depression (Fig. 1). This oasis is physically and culturally isolated; there are no roads except desert tracks leading to the oasis and visitors are infrequent. No previous malaria surveys have been done in El Gara, and only one limited mosquito survey was conducted (Salem 1933). This report documents the presence of *P. vivax* malaria in El Gara Oasis, and describes associated *Anopheles* species collected in larval surveys, and indoor house and animal shed collections.

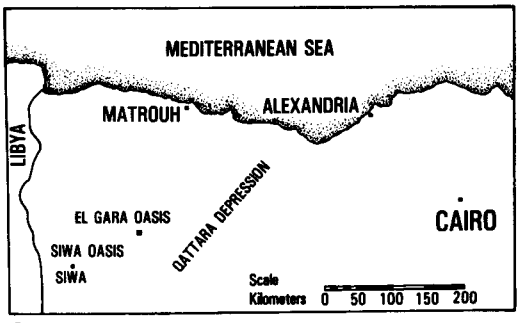

Fig. 1. Map of Egypt showing the location of El Gara Oasis in relation to Siwa Oasis.

Thick blood film samples were taken from 38 of the 180 residents. Selection was based on those willing to give blood during the 1-day visit in April 1983. Age group frequencies included: 7, 1–5 years; 9, 6–10 years; 7, 11–20 years; 11, 21–50 years; 4, 50 years; with 6 females and 32 males. Thick film blood samples were stained and examined by standard techniques (200 fields/thick film).

Of the 38 thick film blood samples, one was positive for *Plasmodium vivax*. The infection was detected in a male, 10 years of age, who did not show symptoms of malaria. This sample of 38 represents 21% of the resident population. In the nearest inhabited area, Siwa Oasis, *P. vivax* persists at a rate less than 1% and is geographically localized (M. A. Kenawy and J. C. Beier, unpublished data). The finding of *P. vivax* in El Gara is, therefore, not unusual.

Mosquito larvae were collected by dippers from breeding sites surrounding the village. Specimens were isolated, placed in 70% alcohol, and later identified at the Ain Shams University in Cairo. All of the 25 occupied houses and adjoining animal sheds were inspected for adult mosquitoes by space-spraying with pyrethroid insecticide. An index sheet (1 m^2) supported by two sticks was moved around the walls and under furniture by one collector while another sprayed insecticide. Mosquitoes were placed in small paper cartons, and transported to Cairo for identification. They were classified according to blood feeding stages as unfed, fed, half-gravid, and gravid. Blood fed females were tested by precipitin test to determine host feeding patterns (Kenawy et al. 1986).

One-hundred and twenty-six mosquito larvae were collected, including *Anopheles sergentii, An. multicolor* Cambouliu, *Culiseta longiareolata* Macquart, *Cs. subochrea* (Edwards) and *Aedes caspius* (Pallas). The two anopheline species were the dominant mosquito larvae collected. Breeding sites included seepage and drainage runoff water from springs, and water channels from the springs. Sites contained abundant algae and peripheral vegetation. One unusual site for *An. sergentii* consisted of a 2 × 8 m^2 basin of cold water originating as seepage from the side of a hill. This site was 0.5 km from the village, contained heavy algal growth, and was probably the main source of *An. sergentii* in El Gara.

Adult mosquito collections in houses and animal sheds yielded 174 *An. sergentii* and 67 *An. multicolor* (Table 1). Forty percent of the houses contained *An. sergentii* while 20% con-

Table 1. Collection of adult *Anopheles sergentii* and *An. multicolor* by space spraying in 25 houses and 7 animal sheds in El Gara Oasis.

	Anopheles sergentii			*Anopheles multicolor*		
	House	Animal shed	Total	House	Animal shed	Total
No. sites positive/ No. inspected	10/25	6/7	16/32	5/25	5/7	10/32
No. females collected	27	147	174	8	59	67
No. females/site	1.1	21.0	5.4	0.3	8.4	2.1
No. females/positive site	2.7	24.5	10.9	1.6	11.8	6.7
Blood feeding stages (%):						
Unfed	3.7	4.1	4.0	0	1.7	1.5
Fed	77.8	81.6	81.0	87.5	86.4	86.1
Half-gravid	14.8	4.8	6.3	12.5	8.5	9.0
Gravid	3.7	9.5	8.6	0	3.4	3.0
Gravid/fed ratio	0.05	0.12	0.11	0	0.04	0.03

tained *An. multicolor*. Over 80% of the anophelines were collected in the 7 animal sheds, and density was around 20 times higher in animal sheds than in houses. Both species fed predominantly on large mammals. The human blood feeding index, for these collected specimens, was 18% (n = 147) for *An. sergentii* and 15% (n = 46) for *An. multicolor* (Kenawy et al. 1986). The zoophilic feeding tendency plus preference for resting in animal shelters, is similar to the situation for these two species in Siwa Oasis (Kenawy et al. 1986).

Examination of specimens for blood-feeding stages showed that over 80% of both species were freshly fed, and less than 5% were unfed. Around 15% of the *An. sergentii* were either half-gravid or gravid compared to 12% for *An. multicolor*. Most gravid specimens were from animal sheds. Females of both species are thus partially endophilic. However, the low gravid to fed ratios indicate that a proportion of the females complete part of their gonotrophic cycles outside houses. Similar observations have been reported for these two species (Gad 1956, Saliternik 1955), with *An. sergentii* sometimes utilizing outdoor shelters remote from human dwellings (Gillies and deMeillon 1968).

The detection of 5 mosquito species in this limited survey does not preclude the possibility of other species existing in El Gara; *Culex deserticola* Kirkpatrick was identified in the only other previous survey (Salem 1933). Similar breeding sites exist in Siwa Oasis where 11 species have been reported (e.g., El Said and Kenawy 1983). As in Siwa, *An. sergentii* and *An. multicolor* are the predominant *Anopheles* species in El Gara.

Anopheles sergentii is most likely the predominant malaria vector in El Gara and the situation appears typical of conditions in nearby Siwa Oasis and other oases (Barber and Rice 1937, Halawany and Shawarby 1957, M. A. Kenawy and J. C. Beier, unpublished). The basis for *An. sergentii* serving as primary vector includes relative larval density, indoor resting density, and previous studies which showed natural sporozoite infections in the Nile Delta (Farid 1940) and in Faiyum (J. C. Beier and M. A. Kenawy, unpublished). *Anopheles multicolor*, however, cannot be ruled out as a possible secondary vector since this is a common species based on larval surveys and indoor collections. Additionally, *An. multicolor* is susceptible to malaria infection in the laboratory (El Said and Farid 1982), although it has never been found naturally infected in Egypt. A main factor which appears to limit oasis malaria transmission in Egypt is the zoophilic feeding behavior of both species (Kenawy et al. 1986).

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