Dubas Bug (Hemiptera: Fulgoroidea: Tropiduchidae): Temperature Effects on the Embryonic Period, and Phenology and Dispersal in Mountain Areas of Oman

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The dubas bug, *Ommatissus lybicus* Bergevin, is a serious tropiduchid (Hemiptera: Fulgoroidea) pest of date palms in Oman and neighbouring countries of the Middle East such as Iraq (Al Khatri, 2004).. Despite the decades that have passed since the first outbreaks of the 1920's and 1930's in Egypt and Iraq (Dowson 1936) and the large accumulation of reports and research articles, countries and researchers in the region are still struggling to manage this pest and to understand its behaviour, biology, and ecology. Here we present two important dubas bug research themes followed in recent years by the entomology lab group of Sultan Qaboos University. These themes are: manipulation of the embryonic period using different temperature regimes, and phenology and dispersal at high elevations.

Laboratory experiments on the dubas bug and rearing of its natural enemies would require a steady ample supply of this insect. To reach such a goal, one needs to develop an efficient and affordable rearing system. Rearing the dubas bug has been hampered mostly by the long period of egg dormancy, which could last not less than 3-4 months during late spring and summer, and during late fall and winter in Oman (Abd-Allah et al. 1998). Egg dormancy is not uncommon in Fulgoroidea (e.g. Okumura 1963). We attempted to break or reduce this dormancy period by exposing eggs to different temperature regimes. In a first round of experiments which involved exposing dubas bug eggs, laid in small seedlings of date palm, to four temperatures (19.6, 25, 29, and 35 ^{o}C), we found that although a temperature of 29 ^{o}C produced the shortest embryonic period (ca. 30 days), the hatching of eggs was staggered over a long period of 70 days. At the more moderate temperature of 25 ^{o}C, the first nymphs to hatch emerged after a longer incubation period than at 29 ^{o}C. but a majority of eggs hatched over a less staggered period of time (55 days). This resulted in a shorter average embryonic period at 25 ^{o}C than at 29 ^{o}C. It was also observed that a relatively large percentage of eggs (40-90%) did not hatch at the tested temperatures even after the passage of 5 months post egg deposition. For the tested temperature range, it was noted that generally the higher the temperature the higher the proportion of unhatched eggs. In a second experiment, we were interested to see whether rearing nymphs from a young age to adulthood in a growth chamber set at moderate temperatures fluctuating from a maximum of 30 ^{o}C during the light period to a minimum of 23 ^{o}C during the dark period (which simulated moderate field temperatures in late winter/ early spring and late fall in Oman) would produce female adults unstressed thermally which in turn might cause these females to lay non-dormant eggs. Thus, early instar nymphs (mostly 1st but some 2nd) were released on small seedlings, and were then allowed to develop on them. Once adults were formed, one female and one male were paired per seedling until oviposition. Resulting eggs were then incubated. All immatures, adults, and eggs were kept at the above stated fluctuating temperature regime. In this latter experiment initial egg hatch started about 2 months after oviposition and egg hatching staggered over a long period of about 5 months post egg laying. During the second experiment, we made an interesting observation. Egg batches, that were laid by field-collected adult females at room temperature (22.5 ^{o}C) and then incubated in a growth chamber set at ca. 26.5 ^{o}C, had their initial hatching after about 30 days. We are planning to continue on the lead of this promising observation by following a similar protocol to arrive at the shortest egg incubation period possible and to shorten the time interval between the first to last egg hatch.

A second research theme dealt with a study of dubas bug in the AlJabal AlAkhdhar area, a high altitude mountain range in northern Oman, where minimum winter temperatures at the ca. 2000 m elevation could reach freezing point on some winter nights while maximum summer temperature are mostly in the low to mid 30's, mild temperatures compared to coast

and plain areas where normal maximum temperatures are in the 40's and 50's from May to August. Although date palms are not cultivated in AlJabal AlAkhdhar because of the unsuitable climate, some scattered wild palms grow in river beds throughout the area. The presence of dubas bug eggs on wild date palms was first detected by our group in 2005. In later years, nymphs and adults were observed on those palms. In early May 2008 we observed for the first time the presence of dubas bug adults on plants other than date palm in different locations of AlJabal AlAkhdhar. It was not clear at that time whether these adults were resident on those plants or whether they were in transit. This initiated interest in studying the population dynamics of dubas bug in this area. In March 2009, we began monitoring adult dispersing dubas bugs by setting up an air-suction trap in a home garden, near Saiq, the main town in the area. At about the same time, we started biweekly monitoring of adults, nymphs, and eggs on five date palms growing in a dry river bed (Wadi AlManakher) about 10 km from Saiq. In late April, we observed large numbers of adult dubas bugs in three locations in the area: on date palms in Wadi AlManakher, on different plants in the home garden near Saiq, and on different wild plants at an elevation of ca.1450m. This influx of large populations of dubas bugs appeared almost suddenly from apparently no where, as no nymphs or new eggs were observed during the preceding period. The sudden appearance of adult dubas bugs were substantiated by data from the air suction trap weekly collections. An abrupt rise in dubas bug numbers was observed in mid to late April 2009. The relatively high numbers of adults continued to be detected in the suction trap collections until about mid May of the same year. The observations of 2008 and 2009 seem to indicate a form of mass migration of the dubas bug from the heavily infested date palm gardens of low elevations around AlJabal AlAkhdhar to high altitudes. This dispersal is possibly caused by crowding and high temperatures and could be powered by convectional rising air currents during daytime. Dispersal of other species of planthoppers has been documented in the literature (e.g. Denno and Roderick 1992) On the wild palms adult numbers gradually declined in May and became very low by mid June. First instar nymphs were observed on palms in late April 2009, while new eggs (laid by the large influx of the mid to late April adults) were first observed in early May. A second generation of nymphs appeared in mid to late July and continued to be observed , albeit in gradually decreasing numbers, until early January 2010. Similarities and dissimilarities between the phenology of dubas bug in AlJabal Alakhdhar in Oman and that of *Ommatissus binotatus* Fieber in Sicily, Italy (Guglielmino 1997) are discussed. We expect to continue the monitoring of dubas bug in mountainous areas of Oman for another 2 years.

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