

DISTRIBUTION OF *BATHYPLECTES CURCULIONIS* AND *BATHYPLECTES ANURUS* [HYM. : ICHNEUMONIDAE] FROM *HYPERA* [COL. : CURCULIONIDAE] ON ALFALFA IN EGYPT, IRAQ, AND IRAN

D. GONZALEZ, L. ETZEL (1), M. ESMAILI (2), A. H. EL-HENEIDY (3)
& I. KADDOU (4)

Division of Biological Control, University of California Riverside, California, U.S.A.

- (1) Division of Biological Control, University of California, Berkeley, California, U.S.A.
(2) Department Plant Protection, College of Agriculture, University Tehran, Karadj, Iran.
(3) Biological Control, Plant Protection Institute, Cairo, Egypt.
(4) Department Biology, College of Science, University Baghdad, Baghdad, Iraq.

A survey for *Hypera postica* (GYLLENHAL) and their larval parasites, *Bathyplectes curculionis* (THOMSON) and *B. anurus* (THOMSON) was conducted from 1973 through 1975 in Egypt, Iraq, and Iran. The search was concentrated in Iraq and Iran in areas having cultivated species of *Medicago*, and in Egypt on *Trifolium alexandrinum* L.

Hypera were most abundant where mean daily temperatures were below 25°C or above 15°C. *B. curculionis* were widely distributed throughout all 3 countries, but were most abundant in the regions having hot, dry summers, with moderately cold winters. *B. anurus* were less abundant and less widely distributed geographically than *B. curculionis*. *B. anurus* were prevalent in regions having moderately warm summers and cold, to very cold, winters. In localities containing both parasites, *B. anurus* reached peak levels about 2-4 weeks before *B. curculionis*.

Mesochorus spp. were the predominant hyperparasites obtained from *Bathyplectes* spp. They were widely distributed in Egypt, Iraq, and Iran.

Significant reduction in alfalfa (*Medicago sativa* L.) yields in the interior valleys in California are caused by feeding of the larvae of *Hypera postica* (GYLLENHAL) (alfalfa weevil, western strain) and *Hypera brunneipennis* (BOHEMAN) (the so-called Egyptian alfalfa weevil) (VAN DEN BOSCH, 1964; BLICKENSTAFF, 1965; DAVIS, 1967). Although entomologists in general refer to these 2 entities as separate species, we consider them in this paper as biotypes of *H. postica* because we have doubts as to the validity of their status as separate species. Our doubts in part are based on the lack of available clear morphological or genetic characters for distinguishing between them. An additional doubt is based on unpublished experiments of CARL KOEHLER (University of California at Berkeley) in which he obtained offspring from reciprocal crosses between ♂ and ♀ of *H. postica* and *H. brunneipennis*. C. KOEHLER (pers. comm., 1978) stated that "The progeny resulting from these crosses reached the adult stage and appeared morphologically normal. Fe-

males outnumbered males by a ratio of 5:3. We were not successful, however, in determining the fertility status of the hybrid adults." Although KOEHLER's tests were incomplete, we believe they support the possibility that *H. brunneipennis* is a biotype or part of a series of biotypes of *H. postica*. We use the term biotype to denote a population of individuals of similar genetic composition for a specific biological attribute. The population may be spatially and temporally sympatric (coincident) with other reproductively compatible populations, but will differ in one or more biological attributes.

We had 2 objectives in the survey reported here: (1) to search for parasites of larvae of *H. postica* from alfalfa in localities near the reported area of origin of alfalfa (ALTEVOGT, 1970), from habitats with climatic patterns similar to those found in California; and (2) to collect parasites from larvae of *H. postica* from different, and geographically distant, habitats to evaluate their effectiveness as biotypes against *H. postica* in the several climatic zones where *Hypera* damage alfalfa in California. (The results of this survey are presented in this paper.)

MATERIALS AND METHODS

Exploration was planned to extend the areas searched by VAN DEN BOSCH in several earlier surveys and was based on his experience with the phenologies of the insects involved (VAN DEN BOSCH, 1964; VAN DEN BOSCH *et al.*, 1971). Data complementary to that provided by VAN DEN BOSCH was available from the study of HAMMAD *et al.* (1968); from locality and phenology data in an unpublished manuscript on Coleoptera of Egypt by M. ALFIERI, available through the courtesy of M. SHELLABI, Plant Protection Institute, Dokki, Egypt; and in the dissertation of ALTEVOGT (1970). The latter found the most primitive type of *Medicago* seed to be indigenous to the Balkans, and the Caucasus Mountains (latitude ca. 40-44°N). Our northernmost locality sampled was Maku, Iran (ca. 39°N) in northwestern Azerbaydzhan, and the southernmost locality was Kom Ombo, Egypt (ca. 25°N). Sites sampled ranged in elevation from sea level to > 3 000 m.

The survey for parasites was conducted by visual inspection of plants and with the aid of a sweep net to collect larvae of *H. postica* primarily in areas having cultivated alfalfa (*Medicago* spp.). In each locality, at least 3 fields were sampled, and each was sampled in at least 3 different sites. A minimum of 200 sweeps with a standard insect sweep net were taken at each site within each field. Qualitative notes were taken on consistency of patterns of abundance and of seasonal occurrence, in lieu of quantitative data. The latter was not possible logistically. Similarly, we searched for larval parasites only, because of logistical limitations resulting from our attempt to collect from many localities. *Onobrychis* spp. (Helba or Sainfoin) and *Trifolium* spp. (cultivated and wild clovers) were also sampled where available, either adjacent to alfalfa, or in the absence of alfalfa (e.g., middle Egypt). Comparisons of abundance of larvae of *H. postica* and their parasites between areas based on samples from *Onobrychis* spp. were not made because that host was not found in most localities, and when present was as an occasional small planting (except in middle Egypt). Unless otherwise noted, our comparisons are based on samples from alfalfa. These comparisons are also limited because the samples were from many unidentified varieties and several species of alfalfa, and it is well-established that there are strong differences in survival and reproduction of larvae of *H. postica* on different varieties (and species) of alfalfa. Once collected, larvae of *H. postica* were placed in paper bags containing bouquets of alfalfa in Iran and Iraq, and Berseem (*T. alexandrinum* L.)

in Egypt. Bouquets were changed approximately 2-3 times/wk. When the host larvae had pupated, cocoons of *Bathyplectes anurus* (THOMSON) and *Bathyplectes curculionis* (THOMSON) that had formed were separated with a flour sieve. Parasite cocoons were then shipped via air freight to the quarantine at the University of California, Berkeley, where the parasites were reared and cultures established.

The cocoons of *Bathyplectes* spp. received in quarantine were disinfected with 0.15 % NaOCl and placed on a cotton pad in a 13-dram plastic vial, the top of which had been pierced several times with a dissecting needle. The vials were then placed in a quart jar containing ca. 250 ml of sand and 2.5 ml of water. The relative humidity in the sealed jar ranged from 80-100 %, and was adequate to prevent desiccation of the cocooned insects. Diapausing insects were held in a 16-h diurnal photophase / 23.0-25.6°C until it was time to break diapause.

The diapause of *B. curculionis* was broken by exposing the cocooned prepupae to 1-2 months of ca. 4.4°C with a 9-h diurnal photophase. Thereupon they were exposed once again to a 16-h diurnal photophase / 23.0-25.6°C. Emergence began in about 10 days under these conditions.

B. anurus has a dual diapause (ETZEL & VAN DEN BOSCH, unpublished) with diapause occurring both in cocooned prepupae and in cocooned adults. The prepupal diapause was broken by exposing cocoons to constant darkness (the jars were tightly wrapped with aluminum foil) and 21.1°C for 50 days. Subsequently, ETZEL found that a better regime for breaking the prepupal diapause of *laboratory-reared B. anurus* is 21.1°C with a diurnal photophase of 11 h. At the end of the 50 days, those individuals which had broken the aestival prepupal diapause were adults, still within their cocoons, and in hibernal diapause. These cocooned adults were exposed to 50 days of ca. 4.4°C with a 9-h diurnal photophase to break the hibernal adult diapause. At the end of this second 50-day period, the cocooned adults were exposed to the same emergence regime as had been used for *B. curculionis*, and the adults began emergence within 2 weeks.

Statistical analyses of data in this study were based on the G-test described in SOKAL & ROHLF (1969).

RESULTS

Localities reported in this survey (table 1) are categorized within 1 of 3 groups based on different climates among the collection sites. Designation of type climates for each group is from WALTER & LEITH (1960):

Group 1: hot, dry regions where summer temperatures are extremely hot and dry, with winters frost-free and relatively mild, and with low rainfall (Egypt, southern Iraq, and Khuzestan Ostan in Iran). Climate in these areas is designated as type III (subtropical: hot and arid). Only *B. curculionis* was found here, occurring ca. 2-10 weeks earlier than in cooler areas (localities in higher elevations and/or more northern latitudes).

Group 2: transitional regions (in the sense of temperature levels, and in abundance of the 2 *Bathyplectes* species), consisted of localities in Iran within the central plateau, in Azerbaydzhan, and in the Zagros Mountains. Summer temperatures are also hot, and the air dry, but both are less intense than in localities listed in (1) above. Winters are colder, and there is a higher amount of rainfall than in areas listed in (1) above. Climate in these sites is designated usually as type VII (arid with cold seasons). Of all areas

TABLE 1

Distribution of primary and secondary parasites of H. postica in Egypt, Iraq, and Iran

	Localities (a)	Number Collected		Period of collections	Number sample days	% Hyperparasites (b)		
		<i>B. anurus</i>	<i>B. curculionis</i>			ex. <i>B. anurus</i>	ex. <i>B. curculionis</i>	
EGYPT								
1974	El-Minya (Middle Egypt)	0	116	21 Feb.-26 March (weekly)	5	(c)	0	
	Nubarria (Lower Egypt near El Eskandariya)	0	352	27 Feb.-23 April (weekly)	7	—	13	
1975	Nubarria	0	219	April	2	—	25	
1977	Nubarria	0	248	23 Mar.-17 April	8	—	17	
IRAQ								
1975	Euphrates River (N. W. from Baghdad)	0	196	30 March-3, 8 April	4	—	2	
	Baghdad area	0	404	17-29 March-2, 8 April	10	—	20	
	Euphrates River (south from Baghdad)	0	1 107	18, 23 March & 2, 8 April	4	—	15	
	Tigris River (S. E. from Baghdad)	0	130	5 April	1	—	1	
IRAN								
1973	Khuzestan (southern desert)	0	69	16-24 April	8	—	42	
	Transitional regions	2 918	3 215	26 April-26 May	18	12	17	
	Alborz Mountain Valleys	1 595	218	26 April-27 May	5	5	17	
1974	Transitional regions	68	432	2 May-7 June	6	3	18	
	Alborz Mountain Valleys	167	42	26 May	1	0	33	
1975	Transitional regions	3 191	4 468	7-25 May	6	9	8	

(a) Specific locality sites :

Egypt 1974

El-Minya : Ben Ibeid, Benisuef, El Qudabi, Seds, Sengers, Tanda.

Iraq 1975

Euphrates River (N. W. from Baghdad) : Al Falluja, Al Haditha, Al Khan, Al Baghdadi, Hit, Ramadi.

Baghdad area : Abu Ghuraib, Adhamiyah, Kadhimiya, Karkh, Tarmiyah.

Euphrates River (South from Baghdad) : Al Kufah, Al Musayab, Babylon, Diwaniyah, Imam Ibrahim, Karbala, Kifil, Rumaitha.

Tigris River (S. E. from Baghdad) : Al Aziziyah, Al Kut.

Iran 1973

Khuzestan : Ahvaz, Deh Luron, Dezful.

Transitional regions : Esfahan, Ghom, Golpaygan, Karadj, Kermanshah, Ghazvin, Sanandaj, Saveh, Varamin, Yazd.

Alborz Mountain Valleys : Ab-e Ali, Damavand, Shemshak, Talegan.

Iran 1974

Transitional regions : Farandavah, Khiov-Azerbaiydzhan, Khacha-Azerbaiydzhan, Sarab, Shiraz, Tabriz, Takestane, Varamin.

Alborz Mountain Valley : Shemshak.

Iran 1975

Transitional regions (Azerbaiydzhan) : Abhar, Ardebil, Farsabad, Jolfa, Kangarlu, Khoiy, Mahabad, Maku Marand, Meshkinshar, Miyaneh, Qarahaghaj, Rezaieyeh, Shahpur, Sufiyan, Tabriz, Zanjan.

(b) % parasitization based only on *Mesochorus* spp. emerged from viable host cocoons.(c) — = *B. anurus* not found in these localities.

sampled, *B. curculionis* was consistently found in greatest abundance from these sites. *B. anurus* was also found in abundance at some localities within this group, but it was not as extensively distributed in high numbers as was *B. curculionis*.

Group 3: cooler regions; of the 3 areas sampled, this is the coldest and has the greatest amount (relatively) of rainfall. Summer temperatures are moderately hot, and winters are cold with snow on the ground and freezing temperatures. All sites in this area were in the Alborz Mountain valleys (northern Iran). The climate in some of these areas is designated type VII, but mostly is type X (mountain). For *B. anurus* peak abundance in these localities was comparable to those localities in the transitional regions that had the highest numbers of *B. anurus*. However, *B. anurus* was uniformly more abundant in the cooler regions than in the transitional regions.

● Levels of abundance between localities can be estimated roughly from data on numbers collected divided by number of sample days (table 1). For example, *B. curculionis* was relatively more abundant in the Euphrates River Basin (south from Baghdad) and in Iranian transitional regions (1975 collections) where ca. 275 and 745 cocoons, respectively, were collected/sample day. There were relatively far less *B. curculionis* in Minya Governorate (Egypt) and in the Euphrates River Basin (northwest from Baghdad) where a mean of ca. 23-50 cocoons were collected/sample day. The widespread distribution of *B. curculionis* was notable because it spanned a wide range of climatic zones over 3 countries. The geographical distribution of *B. anurus* was more restricted, although no samples were taken from cool mountain regions of Iraq. There are no cool regions in Egypt. These results differ from the findings of REECE SAILER (pers. commun., 1979) in the 1960's that "... *Bathyplectes anurus* was the dominant species across southern France, becoming rare in central France and virtually absent in northern France and West Germany. Throughout this area *B. curculionis* was the dominant species..."

Although levels of abundance were comparable in some localities for *B. anurus* and *B. curculionis*, peak abundance occurred at different times. In the transitional regions, in a majority of localities, *B. anurus* reached peak levels about 2-4 weeks before *B. curculionis* (tables 1, 2). The same pattern did not occur in cooler regions, e.g., in Shemshak, Iran, and in the other localities in the mountain valleys. In cooler localities peaks of

TABLE 2

Cocoons of B. anurus and B. curculionis from different elevations at two sampling periods, Iran, 1973

Localities	Altitude (meters)	Collection dates	Number of cocoons		
			<i>B. anurus</i>	<i>B. curculionis</i>	% <i>B. curculionis</i>
Varamin	500-1 000	6-10	616	341	36 a (a)
Karadj	1 000-1 500	May	386	26	6 b
Shemshak	2 000-3 000		130	15	10 b
Varamin	500-1 000		0	303	100 a ¹
Karadj	1 000-1 500		156	466	75 b
Talegan	1 500-2 000	24-27	71	14	17 cd
AB-e Ali	1 500-2 000	May	306	19	6 d
Damavand	1 500-2 000		269	31	10 cd
Shemshak	2 000-3 000		314	73	19 c

(a) Numbers accompanied by different letters are significantly different at $P < 0.05$ as determined with a G test.

abundance of *B. anurus* were delayed by approximately 2 weeks beyond those peaks found in the transitional regions.

Data in table 2 reflect temperature regimes of some localities in relation to abundance of the 2 primary parasite species. We compared cocoon numbers of each of the 2 *Bathyplectes* species from several localities in close proximity to one another and from 2 time periods. The higher numbers of *B. anurus* in the earlier sampling period were from the lower elevations. The reverse occurred at the later sampling date for the same species. Higher numbers of *B. curculionis* were collected at the lower elevations than at the higher elevations, for both sampling dates. Above 1 500 meters elevation, the percentages of *B. anurus* in the collections were greater than 80 % for each of the 2 sampling periods. From the statistical evaluations on abundance of the 2 species at various elevations, it is obvious that significant differences in numbers of *B. anurus* and *B. curculionis* occur between the warmest and coolest areas with *B. curculionis* predominant in the former and lowest in the latter.

Data on adult hyperparasites are based on their numbers emerging from viable cocoons. Of the emerged adults, the great majority were *Mesochorus* spp. [Hym. : Ichneumonidae]. The species of *Mesochorus* had a wide distribution. They were present in Nubarria, Egypt, in 1974, 1975, and 1977; in at least 70 % of the localities sampled in Iraq in 1975; and in 70-100 % of localities sampled in Iran in 1973-75. Hyperparasites of the family *Pteromalidae* (*Sceptrothelys* spp.) emerged from *Bathyplectes* cocoons collected at 3-35 % of the localities sampled in Iran in 1973-75. Very rarely, parasites from the family *Eulophidae* (*Tetrasticus* spp.) were also obtained: in 1973, 1 specimen emerged from a collection near Varamin, Iran and 7 other specimens were obtained from Shemshak, Iran. The pteromalids were present in the following Iranian areas which are geographically widely separated and differ appreciably in elevation and in climate: Varamin, Sanandaj, Shemshak, Ghazvin, Karadj, Golpaygan, Sarab and Shahpur. The pteromalids were gregarious, with commonly 3-4 individuals emerging from a host cocoon. The pteromalids would attack unparasitized cocoons of *Bathyplectes*. The species of *Mesochorus* recovered, on the other hand, are solitary parasites and do not attack cocoons of *Bathyplectes*, but only larvae of *Bathyplectes* present within *Hypera* larvae.

For *B. anurus*, on the basis of data groupings for several areas (table 1), hyperparasitism from *Mesochorus* spp. did not exceed 12 %. From individual localities, the highest hyperparasitism from *Mesochorus* spp. on *B. anurus* was 39 % in 1 sample of 67 viable cocoons from Saveh in 1973, and 35 % in a sample of 201 viable cocoons from near Tabriz in 1975. However, those samples were from small and declining populations late in the season. From another 25 samples, with a total of 3 474 viable cocoons of *B. anurus*, hyperparasitism by *Mesochorus* was less than 20 %. The range of percentage of hyperparasitism from 27 samples was 0-39 %, with a mean of 11 % and a median of 10 %.

Data compiled for Iranian areas (table 1) indicated greater hyperparasitism by *Mesochorus* on *B. curculionis* than on *B. anurus*, with the exception of the 1975 data from Azerbaydzhan. On an area-wide basis, the highest hyperparasitism against *B. curculionis* was 42 % of 69 cocoons from the 1973 Iranian Khuzestan localities. Samples from Varamin, Iran, collected over a 1-month period in 1973 averaged 21 % *Mesochorus* emergence from *B. curculionis*. From individual Iranian localities in 1973, the highest hyperparasitism of *B. curculionis* by *Mesochorus* was 56 % of 25 cocoons collected at Yazd, and 52 % of 42 cocoons collected at Esfahan.

Percentage hyperparasitism of *B. curculionis* by *Mesochorus* in 4 areas of grouped localities in Iraq 1975 ranged from 1-20 %. However, the Iraqi data were from declining

TABLE 3

Sex ratios of B. curculionis from Egypt, Iraq, and Iran

Country		Numbers		\bar{x} % ♀♀
		♀♀	♂♂	
Egypt	1974	119	135	51 a (a)
	1975	19	22	
	1977	61	36	
Iraq	1975	283	143	66 c
Iran	1973	759	564	57 b
	1974	108	74	
	1975	1 579	1 176	

(a) Numbers followed by different letters are significantly different at $P < 0.05$ as determined with a G test.

TABLE 4

Sex ratios of Mesochorus spp. from Egypt, Iraq, and Iran

Country		Host	Numbers		% ♀
			♀	♂	
Egypt	1974	<i>B. curculionis</i>	19	18	51
	1975	<i>B. curculionis</i>	15	18	46
	1977	<i>B. curculionis</i>	16	15	52
Iraq	1974	<i>B. curculionis</i>	139	84	62 a (a)
Iran	1973	<i>B. curculionis</i> and <i>B. anurus</i>		334	59 a
	1974	<i>B. curculionis</i>	30	38	44
	1975	<i>B. curculionis</i> and <i>B. anurus</i>	259	300	46 b

(a) Numbers followed by different letters are significantly different at $P < 0.05$ as determined with a G test.

populations in low numbers (table 4) at the end of the season for larvae of *H. postica*, and thus we make no inferences from these data.

The range of hyperparasitism in Egypt was similar to that in Iraq. In both countries there were areas with relatively high percentage parasitism by hyperparasites, but actually low numbers of hyperparasites were found because the collections were from the end of the season. As in Iraq, the Egyptian data were too few in numbers from specific localities, and we make no inferences from these data (table 4).

In general, the higher rates of hyperparasitism were from later sampling dates. From these limited data we speculate that hyperparasites are not a principal factor limiting the effectiveness of the primary parasites against larvae of *H. postica* in these localities.

The percentage of females of *B. curculionis* given in table 3 varied from 46 to 66 % depending on the location and year. The small samples and unexplainable variation limit further interpretation of these data. There were no significant differences between

the overall sex ratios of *B. curculionis* and *B. anurus* for the 1973 and 1975 Iranian samples: 1973, *B. anurus* = 60 % ♀, *B. curculionis* = 57 %; 1975, *B. anurus* = 59 %, *B. curculionis* = 57 %.

In table 3 we list the actual numbers of adult *B. curculionis* that emerged in quarantine after being held under laboratory conditions. Compared with numbers collected (table 1) the figures in table 3 are relatively low. The actual numbers emerged, in relation to numbers collected, indicate emergence ranging from 19 % (Egypt, 1975) to 62 % (Iran 1975). Other levels of emergence were Egypt 1974 (54 %), 1977 (39 %); Iran 1973 and 1974 (38 %); and Iraq 1975 (23 %). These data reflect the effects of hyperparasitism, and the variable and uncontrolled conditions from the time of field collection and subsequent shipment until the cocoons arrived at the quarantine facility (2-4 weeks after collection). The emergence was also due to variable responses to laboratory regimes imposed for diapause termination. Because of these circumstances, these data are not reliable estimates of the percentage of field emergence one might expect from any of the collection localities.

In examining the sex ratios of *Mesochorus* spp. (table 4), only those ratios between the Iranian 1973 and 1975 data were significantly different. Although data are given for 3 countries, those from Egypt and those from Iran 1974 were not analyzed statistically because of the low numbers that emerged. Thus, we make no inferences from these data.

DISCUSSION

We tentatively conclude from this survey that the geographical distribution and abundance of *H. postica*, *B. anurus*, and *B. curculionis* are mainly related to (1) temperature, (2) shelter vegetation, and (3) host plants.

We believe that temperature is the single most important factor affecting abundance and seasonal occurrence of larvae of *H. postica* populations and their parasites in the sites sampled. For example, in Kom Ombo, Egypt (the most southerly and lowest elevation locality sampled), where heat was most intense (mean daily temperature 20°C in February), larvae of *H. postica* were extremely rare, and no parasites were found. The same pattern of low numbers of larvae of *H. postica* and no parasites occurred at elevations > 3 000 m in the Alborz Mountains (mean daily temperature 15°C in June). Intermediate levels of abundance of larvae of *H. postica*, *B. anurus*, and *B. curculionis* (where alfalfa was available), and also their seasonal occurrence, were most closely associated with temperature regimes. In the hot desert areas where larvae of *H. postica* and their parasites occurred earliest, and in lowest numbers, the mean daily temperatures over a 20 year period were ca. 15°C in February and 20°C in March (WALTER & LEITH, 1960). The transitional zones (Iran), from where we collected the preponderant number of larvae of *H. postica*, *B. anurus*, and *B. curculionis*, have temperature patterns that are less intense than those of the desert areas, with a corresponding delay in the seasonal occurrence of larvae of *H. postica* and their parasites. Yazd, Ghom and Varamin have records of mean daily temperature levels of ca. 10°C, 15°C, 20°C, and 25°C respectively for February, March, April and May. In several sites from Azerbaydzhan and also from Karadj, the corresponding mean daily temperature records are ca. 5°C, 10°C, 15°C, and 20°C. In climates with extreme cold, in the Alborz Mountain Valleys, the corresponding mean daily temperatures for February through May were ca. < 0°C, 0°C, 5-10°C, and 10-15°C respectively. Larvae of *H. postica* were notably in fewer numbers here than they were

in the transitional zones. Cocoons of *H. postica* (a simple index of surviving larval populations) were most scarce in localities and/or at times of the year, where mean daily temperatures (based on records of monthly means) increased beyond 25°C or were below 15°C, or where strong winds are prevalent, e.g., especially in open fields with no shelter or protection from trees, shrubs or other vegetation serving as a wind break. VAN DEN BOSCH (1964) reported "...the only damaging populations that were observed occurred in clover planted in date palm groves..."

Two localities with high levels of parasite abundance in the transitional zone of Iran (Varamin, Karadj) had 2-3 generations per year of larvae of *H. postica* and 2 or more of *B. curculionis* (unpublished data of M. ESMALI). Conversely, localities with more severely limiting temperatures (e.g., in desert areas or in mountain valleys) generally had only 1 generation/year of each species. VAN DEN BOSCH (1964) reported 2 generations/year of *B. curculionis* in Egypt, but we found only 1.

Different patterns of abundance and of phenologies occurred from populations of the same species in localities in close proximity but having different temperature regimes (e.g., Varamin and Shemshak). In contrast, similar patterns of abundance occurred between populations (same species) distantly located (Imam Ibrahim, Varamin, and Rezaiyeh) but with similar temperature patterns. The effect of temperature on alfalfa weevil populations has been reported extensively by others (numerous references in COTHRAN, 1972). COOK (1925) and MICHELbacher & LEIGHLY (1940) analyzed climatic patterns within the known distributions of alfalfa weevils and pointed out limiting temperature regimes similar to the ones we described. BASS (1966) and SWEETMAN & WEDEMEYER (1933) obtained more precise laboratory data on the effects of temperature on alfalfa weevils.

High relative humidity (ca. > 80 % R.H.) was essential for emergence of *B. anurus* held under laboratory conditions. Observations in the field tend to support the laboratory findings and a hypothesis that relative humidity may also be a critical factor under field conditions, particularly in unsheltered areas subjected to persistent dry winds.

In all areas, alfalfa fields with more exposure to winds had lower numbers of larvae of *H. postica* (populations) than sheltered fields. However, shelter may provide several types of refuge in addition to reducing desiccation. It may also provide refuges from extremes of heat or cold. Within fields located adjacent to vegetative barriers (shrubs; Palm, Tamarisk, or Eucalyptus trees), levels of larvae of *H. postica* and of their parasites were generally higher in the alfalfa adjacent to the vegetative barrier, particularly more so when that barrier was up-wind from the field, from the direction of the predominant wind pattern.

Potential biotype differences among parasites were notable from several populations. The amount of complete hemocytic encapsulation (a defense host reaction) suffered by eggs of *B. curculionis* in larvae of *H. postica* from Nubarria, was significantly less than that for *B. curculionis* infested hosts from Iran or Iraq (unpublished data of C. MERRITT, R. VAN DEN BOSCH, L. ETZEL & R. TASSAN). Also, SALT & VAN DEN BOSCH (1971) found that 2 "strains" (biotypes) of *B. curculionis* evoked different degrees of encapsulation of parasite eggs by larvae of the host, *H. brunneipennis*. From collections in the mid 1960's in Switzerland R. I. SAILER (pers. commun., 1979) found that "Each valley population of *Hypera* would show a different level of ability to encapsulate *B. curculionis* eggs and newly hatched larvae." WALKER (1959) also demonstrated that intraspecific strains (biotypes) of a species of parasitic Hymenoptera may differ in their relation to the defense reactions of a host. With *B. anurus*, diapause differences were found between various populations. For example, more time was required to break diapause in the laboratory for *B. anurus*

from Khiov-Azerbaydzhan than for *B. anurus* from either Shemshak or Varamin (unpublished data of L. ETZEL).

We have mixed opinions regarding an evaluation of the results from this survey, relevant to the potential for biological control of *H. postica* by *B. anurus* and/or *B. curculionis*. On the negative side, higher numbers of parasites were found most usually in fields having high numbers of unparasitized larvae of *H. postica*. This occurred consistently throughout the different habitats surveyed including alfalfa fields searched recently in the Sahara Desert. In all localities except Golpaygan, the *H. postica* larval populations contained mixed age groups, with large numbers of maturing larvae and unparasitized prepupae indicating high rates of survival in the presence of parasites. In Golpaygan, there were relatively high numbers of both *B. anurus* and *B. curculionis* from cocoons from a moderate level *H. postica* larval population. The latter consisted predominantly of young larvae.

On a positive note, we are particularly optimistic about the *B. curculionis* from Iraq and El-Minya because of their potential effectiveness in the hot, climatic regions of California, and also about the *B. curculionis* from Nubarria, because of their resistance to the host defense reaction of larvae of *H. postica*.

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RÉSUMÉ

Distribution de *Bathyplectes curculionis* et *B. anurus* [Hym. : Ichneumonidae] parasites de *Hypera* [Col. : Curculionidae] sur la luzerne en Égypte, Irak et Iran

La répartition géographique des *Hypera* spp. (Col. : Curculionidae) et de ses parasites larvaires, *Bathyplectes curculionis* (THOMSON) et *B. anurus* (THOMSON) (Hym. : Ichneumonidae) a été étudiée de 1973 à 1975 en Irak et en Iran, dans les régions où sont cultivées les espèces de *Medicago*, et en Égypte sur *Trifolium alexandrinum* L.

Les *Hypera* spp. ont été trouvés en plus grand nombre là où la moyenne quotidienne des températures était inférieure à 25°C ou supérieure à 15°C. *B. curculionis* était largement répartie dans l'ensemble des 3 pays, mais plus abondante dans les régions à étés chauds et secs et à hivers modérément froids.

B. anurus était moins abondante et moins largement répartie géographiquement que *B. curculionis*. *B. anurus* était dominante dans les régions à étés modérément chauds et à hivers froids ou très froids. Là où les 2 espèces étaient présentes, *B. anurus* était abondante 2 à 4 semaines avant *B. curculionis*.

Les hyperparasites *Mesochorus* spp. ont été abondants sur *Bathyplectes* spp., leur répartition couvrant largement l'Égypte, l'Irak et l'Iran.

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