

Role of Parasitoid Complex in Limiting the Population of Diamondback Moth in Moldavia, Romania

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Abstract

The complex of parasitoid and hyperparasitoid species which is associated with diamondback moth (*Plutella xylostella* (L.)), a destructive pest of cabbage in Romania, is presented. Over 25 species of Ichneumonidae and Braconidae are identified, which act as primary and secondary parasitoids. For each species, abundance, constancy, dominance, the biocenotic affinity and the contribution of each species in limiting the population of diamondback moth is analyzed. The dynamics of these species over time, from one crop to another and from one area to another are discussed. Also discussed are those species which play a role in biological control of this pest, and those which could be used in biocontrol.

Introduction

Diamondback moth (DBM), *Plutella xylostella* (L.) (Lepidoptera: Yponomeutidae) is one of the most serious pests of cabbage in Romania. In Moldavia this species completes two or three generations in one crop season (Peiu et al. 1971, 1973). The greatest damage occurs when the infestation takes place in young plants. In older plants the larvae develop mainly on the outer leaves. Such damage is of little economic significance. Larvae from the first and second generations cause the greatest damage in Moldavia.

Our research was aimed at clarifying the complex of parasitoids that limited the population of DBM.

Materials and Methods

The research was conducted in three stages: 1967-72, 1979-82 and 1990. In the first stage, we emphasized identification of the parasitoid species and their interrelationship. In the second and third stages, the importance of each species within the biocenotic complex and the contribution of each species in limiting populations of DBM was considered.

Based on the material collected from over 40 localities in Moldavia during the study period, we found that DBM was controlled by a complex of parasitoid species that reduced the populations of this pest by 80-90% or even more.

We collected 16,961 mature larvae and pupae of DBM. They were reared in the laboratory for adult parasitoid emergence, identification and synecological studies.

Results and Discussion

Of the 16,981 larval specimens collected from 1967 to 1972 (Table 1), 1514 larvae and pupae (8.9%) died due to diseases and insecticides. A total of 4777 pupae emerged into DBM

adults (28.2%). The balance of the collection, 10,670 specimens, emerged into parasite adults. They belonged to 28 species, as follows.

Table 1. The synecological analysis of the parasitoid species in the populations of DBM.

Species	Abundance	Dominance	Constancy	Index of ecological significance
<i>Diadegma fenestralis</i>	3,182	18.76 D5	88 C4	16.50 W5
<i>Diadegma armillata</i>	1,773	10.45 D5	79 C4	8.25 W4
<i>Diadegma chrysosticta</i>	1,749	10.31 D5	76 C4	7.83 W4
<i>Diadegma vestigialis</i>	754	4.44 D3	52 C3	2.30 W3
<i>Diadromus subtilicornis</i>	623	3.67 D3	45 C2	1.65 W3
<i>Diadegma cerophaga</i>	560	3.30 D3	62 C3	2.04 W3
<i>Diadromus collaris</i>	364	2.14 D3	42 C2	0.89 W2
<i>Diadromus ustulatus</i>	347	2.04 D3	38 C2	0.77 W2
<i>Diadegma tibialis</i>	251	1.47 D2	44 C2	0.64 W2
<i>Diadegma trochanterata</i>	227	1.33 D2	43 C2	0.57 W2
<i>Apanteles fuliginosus</i>	215	1.26 D2	39 C2	0.49 W2
<i>Diadegma gracilis</i>	81	0.47 D1	20 C1	0.09 W1
<i>Diadegma gibbula</i>	54	0.31 D1	15 C1	0.04 W1
<i>Diadegma holopyga</i>	41	0.24 D1	26 C2	0.06 W1
<i>Diadegma interrupta</i>	39	0.22 D1	16 C1	0.03 W1
<i>Itopectis alternans</i>	36	0.21 D1	27 C2	0.05 W1
<i>Phaeogenes ischiomelinus</i>	36	0.21 D1	16 C1	0.03 W1
<i>Dicaelotus parvulus</i>	32	0.18 D1	19 C1	0.03 W1
<i>Itopectis viduata</i>	25	0.14 D1	18 C1	0.02 W1
<i>Itopectis tunetanus</i>	24	0.14 D1	11 C1	0.01 W1
<i>Diadegma monospila</i>	22	0.12 D1	14 C1	0.01 W1
<i>Hyposoter ebeninus</i>	8	0.04 D1	7 C1	0.002 W1
<i>Apanteles ruficrus</i>	8	0.04 D1	8 C1	0.003 W1
<i>Apanteles rubecula</i>	4	0.02 D1	4 C1	0.0008 W1
<i>Nepiera moldavica</i>	3	0.01 D1	1 C1	0.0001 W1

Primary parasitoids

A. Family Ichneumonidae: 1. *Itopectis viduata* Grav., 2. *I. tunetanus* Schm., 3. *I. alternans* Grav., 4. *Nepiera moldavica* Const. and Must., 5. *Diadegma armillata* Grav., 6. *D. cerophaga* Grav., 7. *D. chrysosticta* Gmel, 8. *D. fenestralis* Holmgr., 9. *D. gibbula* Brsch., 10. *D. gracilis* Grav., 11. *D. holopyga* Thoms., 12. *D. interrupta* Holmgr., 13. *D. monospila* Thoms., 14. *D. tibialis* Grav. 15. *D. trochanterata* Thoms., 16. *D. vestigialis* Rtzbg., 17. *Hyposoter ebeninus* Grav., 18. *Dicaelotus parvulus* Grav., 19. *Diadromus subtilicornis* Grav., 20. *D. ustulatus* Holmgr., 21. *Thyraeella collaris* Grev., 22. *Phaeogenes ischiomelinus* Grav.

B. Family Braconidae: 1. *Apanateles fuliginosus* Wesm., 2. *A. rubecula* Marsh., 3. *A. ruficrus* (Hal.).

C. Family Pteromalidae: *Dibrachys cavus* (Walk.). D. Family Eulophidae: 1. *Tetrastichus* sp., 2. *Geniocerus* sp.

Secondary parasitoids

A. Family Ichneumonidae: *Mesochorus vittator* Zett., of *Diadegma armillata* Grav.; *Lysibia varitarsus* of *Apanteles fuliginosus* (Wesm.).

B. Family Eulophidae: *Pleurotropis* sp. of *Diadegma armillata* and *Apanteles fuliginosus*;

C. Family Pteromalidae: *Eupteromalus* sp. of *Diadegma armillata*.

The action of the secondary parasitoids limits the efficiency of the primary parasitoids in controlling DBM populations. However, their presence is negligible and has no significant economic impact.

The interrelations between the species of this biocenotic complex are shown in Fig. 1.

Studies of parasitoid species identified in this complex (Table 1) indicate that there is considerable variation in these parasite species. Their high numbers and the high rate of parasitism puts *D. fenestralis* (18.8%) in the first place, followed by *D. armillata*, *D. chrysostricta*, *D. vestigialis*, *Diadromus subtilicornis*. Other species play a minor role in reducing host populations.

The relation between the parasitoid species varies from sample to sample in the same locality, from time to time during the year, from year to year and from area to area.

The large number of species that seem to parasitize DBM raises a legitimate question: Is each species closely associated with this host, or have some species reached this parasite complex more or less accidentally? To answer this question we carried out a synecological analysis of the populations of parasitoids within the biocenotic complex. Table 1 lists abundance, dominance, constancy and the index of ecological significance for each species.

The species are listed according to their abundance. The highest value is assigned to *D. fenestralis* with 3182 individuals, followed by *D. armillata* with 1773 individuals and *D. chrysostricta* with 1749 individuals. The lowest values were assigned to *A. rubecula* and *Nepiera moldavica* with only three individuals each.

To judge the importance of the presence of parasitoid species within this complex, we carefully analyzed their constancy as a structural indicator because this indicates the contribution of a species participating in the realization of the structure of the biocenosis.

From the ecological parameters we can deduce that species *D. fenestralis*, *D. armillata* and *D. chrysostricta* act as euconstant parasitoids, whereas *D. vestigialis* and *D. cerophaga* act as constant parasitoids. This means that all these species can be found in all the cabbage fields from Moldavia, wherever DBM attacks cabbage. Eight species act as accessory parasitoids and the other species can be considered as accidentally present in this complex.

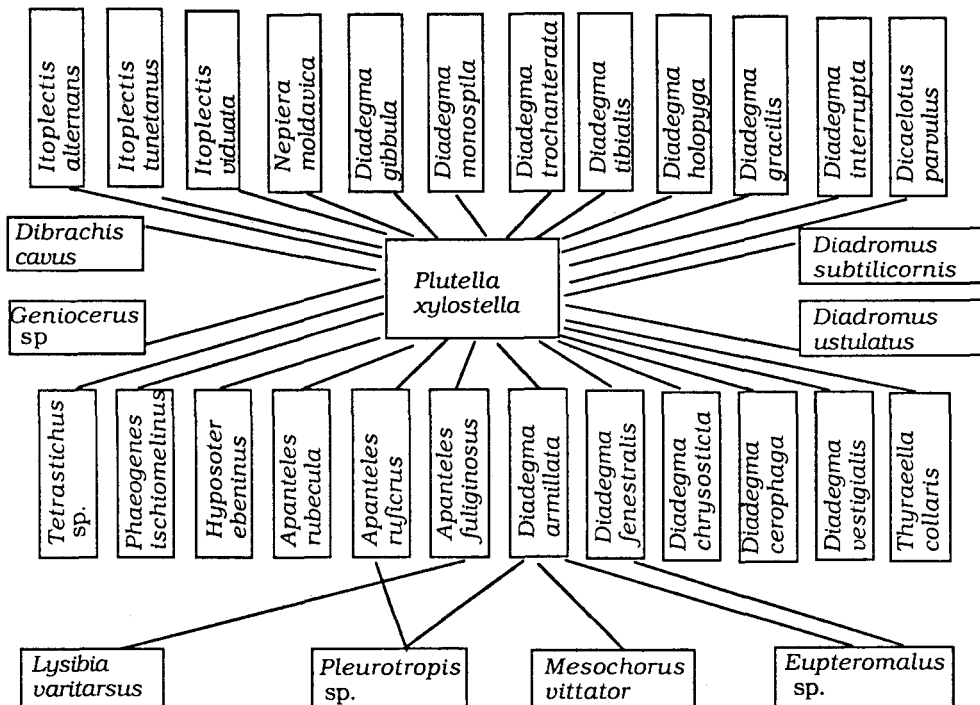


Fig. 1. The complex of parasitoids which limits the population of DBM in Moldavia, Romania.

Dominancy shows the number relationship of the individuals of a given species in contrast to the number of individuals of the other species they associate with. It indicates the relative abundance. The dominance parameter illustrates the participating degree of each species to the realization of biomass production in biocenosis. The species *D. fenestralis*, *D. armillata* and *D. chrysosticta* are eudominant; *D. vestigialis* is dominant; *Diadromus subtilicornis*, *D. ustulatus*, *Diadegma cerophaga* and *Diadromus collaris* are subdominant, followed by three recedent species and all the others subrecedent.

The index of ecological significance (W) represents the relationship between the structural and productive indicators. This shows more eloquently the position of each species in the complex. In this respect, the highest value is that of *D. fenestralis*, followed by *D. armillata* and *D. chrysosticta* with W_4 and by *D. vestigialis*, *D. cerophaga* and *Diadromus subtilicornis* with W_3 , after which there follows five species with W_2 , the others having reduced values.

Synecological analysis of the data obtained from our research indicates that only a few species make a major contribution in limiting populations of DBM to over 80%. This fact has important practical significance.

In order to convince ourselves that this complex of parasitoid species limits the populations of DBM, we continued our research (Mustata 1979, 1987; Mustata and Tudor 1973; Mustata and Lacatusu 1973).

Our initial survey from 1967 to 1979 identified all the parasite species that interact with the populations of this pest (Table 2). These parasitoid species considerably reduce the populations of DBM. The degree of parasitism varied between 13.9% in Ciurea, on 21 July 1971 and 95.6% in Ungureni on 21 August 1972. In most of the samples the percentage of parasitism is quite high, averaging 60.9%.

The value of the ecological parameters resulting from the analysis of the data obtained from 1979 to 1982 is shown in Table 3.

The data from the last study period (1990) are summarized in Table 4. Here, too, the same parasitoid species manifest themselves as being euconstant or constant, eudominant or dominant, and have a high index of ecological significance although there is reversal in the order and value of the ecological parameters.

We also analyzed the index of biocenotic affinity, the value which confirms the affinity between the main species derived from results obtained in the first stage.

The role of the main parasitoid species in limiting the populations of DBM in Adjudu Vechi and their dynamics in time and space are shown in Fig. 2. The number of DBM adults that emerged was very low. During 1969-71, the DBM emergence was close to 30%, whereas in 1972, 1979, 1980 and 1981 it was 4%. In 1972, it reached 69.5% and in 1990 it declined to 17.9%.

Diadegma armillata, *D. fenestralis*, and *D. chrysosticta* seem to be the major parasitoids limiting the populations of DBM. Other species of primary parasitoids with a clean competition between them also limit the populations of DBM.

Our results on the dynamics of the main parasite species at various locations in Moldavia during 1969 are summarized in Fig. 3, and for 1990 in Fig. 4. The localities shown in Fig. 4 are listed according to their geographical position from the south (Homocea) to the north (Mestecanis) of Moldavia. There is no relationship between the geographic location and populations of DBM or its major parasites.

On the basis of our research we could deduce that populations of DBM in Moldavia are limited by an important complex of natural enemies, their efficiency being very high (about 63%). Some of the parasitoid species are constant or euconstant in populations of DBM. The more important species are *D. fenestralis*, *D. armillata*, *D. chrysosticta*, *D. vestigialis*, *D. cerophaga*, and *Diadromus subtilicornis*. The combined parasitism of these major species and certain minor ones play an important part in DBM control in Moldavia. However, we often found that chemical insecticides were used despite levels of parasitism of almost 90%. In July 1972 in Adjudu Vechi and July 1970 in Scheia, farmers used chemicals to combat DBM although the samples taken only 8-10 days earlier showed only 4-5.5% DBM adult emergence. The balance,

Table 2. The synecological analysis of the parasitoid species in the period 1967-72.

Species	14,13 W5	16,12 W5	17,13 W5	18,14 W5	19,15 W5	20,16 W5	21,17 W5	22,18 W5	23,19 W5	24,20 W5	25,21 W5	26,22 W5	27,23 W5	28,24 W5	29,25 W5	30,26 W5	31,27 W5	32,28 W5	33,29 W5	34,30 W5	35,31 W5	36,32 W5	37,33 W5	38,34 W5	39,35 W5	40,36 W5	41,37 W5	42,38 W5	43,39 W5	44,40 W5	45,41 W5	46,42 W5	47,43 W5	48,44 W5	49,45 W5	50,46 W5	51,47 W5	52,48 W5	53,49 W5	54,50 W5	55,51 W5	56,52 W5	57,53 W5	58,54 W5	59,55 W5	60,56 W5	61,57 W5	62,58 W5	63,59 W5	64,60 W5	65,61 W5	66,62 W5	67,63 W5	68,64 W5	69,65 W5	70,66 W5	71,67 W5	72,68 W5	73,69 W5	74,70 W5	75,71 W5	76,72 W5	77,73 W5	78,74 W5	79,75 W5	80,76 W5	81,77 W5	82,78 W5	83,79 W5	84,80 W5	85,81 W5	86,82 W5	87,83 W5	88,84 W5	89,85 W5	90,86 W5	91,87 W5	92,88 W5	93,89 W5	94,90 W5	95,91 W5	96,92 W5	97,93 W5	98,94 W5	99,95 W5	100,96 W5	101,97 W5	102,98 W5	103,99 W5	104,100 W5	105,101 W5	106,102 W5	107,103 W5	108,104 W5	109,105 W5	110,106 W5	111,107 W5	112,108 W5	113,109 W5	114,110 W5	115,111 W5	116,112 W5	117,113 W5	118,114 W5	119,115 W5	120,116 W5	121,117 W5	122,118 W5	123,119 W5	124,120 W5	125,121 W5	126,122 W5	127,123 W5	128,124 W5	129,125 W5	130,126 W5	131,127 W5	132,128 W5	133,129 W5	134,130 W5	135,131 W5	136,132 W5	137,133 W5	138,134 W5	139,135 W5	140,136 W5	141,137 W5	142,138 W5	143,139 W5	144,140 W5	145,141 W5	146,142 W5	147,143 W5	148,144 W5	149,145 W5	150,146 W5	151,147 W5	152,148 W5	153,149 W5	154,150 W5	155,151 W5	156,152 W5	157,153 W5	158,154 W5	159,155 W5	160,156 W5	161,157 W5	162,158 W5	163,159 W5	164,160 W5	165,161 W5	166,162 W5	167,163 W5	168,164 W5	169,165 W5	170,166 W5	171,167 W5	172,168 W5	173,169 W5	174,170 W5	175,171 W5	176,172 W5	177,173 W5	178,174 W5	179,175 W5	180,176 W5	181,177 W5	182,178 W5	183,179 W5	184,180 W5	185,181 W5	186,182 W5	187,183 W5	188,184 W5	189,185 W5	190,186 W5	191,187 W5	192,188 W5	193,189 W5	194,190 W5	195,191 W5	196,192 W5	197,193 W5	198,194 W5	199,195 W5	200,196 W5	201,197 W5	202,198 W5	203,199 W5	204,200 W5	205,201 W5	206,202 W5	207,203 W5	208,204 W5	209,205 W5	210,206 W5	211,207 W5	212,208 W5	213,209 W5	214,210 W5	215,211 W5	216,212 W5	217,213 W5	218,214 W5	219,215 W5	220,216 W5	221,217 W5	222,218 W5	223,219 W5	224,220 W5	225,221 W5	226,222 W5	227,223 W5	228,224 W5	229,225 W5	230,226 W5	231,227 W5	232,228 W5	233,229 W5	234,230 W5	235,231 W5	236,232 W5	237,233 W5	238,234 W5	239,235 W5	240,236 W5	241,237 W5	242,238 W5	243,239 W5	244,240 W5	245,241 W5	246,242 W5	247,243 W5	248,244 W5	249,245 W5	250,246 W5	251,247 W5	252,248 W5	253,249 W5	254,250 W5	255,251 W5	256,252 W5	257,253 W5	258,254 W5	259,255 W5	260,256 W5	261,257 W5	262,258 W5	263,259 W5	264,260 W5	265,261 W5	266,262 W5	267,263 W5	268,264 W5	269,265 W5	270,266 W5	271,267 W5	272,268 W5	273,269 W5	274,270 W5	275,271 W5	276,272 W5	277,273 W5	278,274 W5	279,275 W5	280,276 W5	281,277 W5	282,278 W5	283,279 W5	284,280 W5	285,281 W5	286,282 W5	287,283 W5	288,284 W5	289,285 W5	290,286 W5	291,287 W5	292,288 W5	293,289 W5	294,290 W5	295,291 W5	296,292 W5	297,293 W5	298,294 W5	299,295 W5	300,296 W5	301,297 W5	302,298 W5	303,299 W5	304,300 W5	305,301 W5	306,302 W5	307,303 W5	308,304 W5	309,305 W5	310,306 W5	311,307 W5	312,308 W5	313,309 W5	314,310 W5	315,311 W5	316,312 W5	317,313 W5	318,314 W5	319,315 W5	320,316 W5	321,317 W5	322,318 W5	323,319 W5	324,320 W5	325,321 W5	326,322 W5	327,323 W5	328,324 W5	329,325 W5	330,326 W5	331,327 W5	332,328 W5	333,329 W5	334,330 W5	335,331 W5	336,332 W5	337,333 W5	338,334 W5	339,335 W5	340,336 W5	341,337 W5	342,338 W5	343,339 W5	344,340 W5	345,341 W5	346,342 W5	347,343 W5	348,344 W5	349,345 W5	350,346 W5	351,347 W5	352,348 W5	353,349 W5	354,350 W5	355,351 W5	356,352 W5	357,353 W5	358,354 W5	359,355 W5	360,356 W5	361,357 W5	362,358 W5	363,359 W5	364,360 W5	365,361 W5	366,362 W5	367,363 W5	368,364 W5	369,365 W5	370,366 W5	371,367 W5	372,368 W5	373,369 W5	374,370 W5	375,371 W5	376,372 W5	377,373 W5	378,374 W5	379,375 W5	380,376 W5	381,377 W5	382,378 W5	383,379 W5	384,380 W5	385,381 W5	386,382 W5	387,383 W5	388,384 W5	389,385 W5	390,386 W5	391,387 W5	392,388 W5	393,389 W5	394,390 W5	395,391 W5	396,392 W5	397,393 W5	398,394 W5	399,395 W5	400,396 W5	401,397 W5	402,398 W5	403,399 W5	404,400 W5	405,401 W5	406,402 W5	407,403 W5	408,404 W5	409,405 W5	410,406 W5	411,407 W5	412,408 W5	413,409 W5	414,410 W5	415,411 W5	416,412 W5	417,413 W5	418,414 W5	419,415 W5	420,416 W5	421,417 W5	422,418 W5	423,419 W5	424,420 W5	425,421 W5	426,422 W5	427,423 W5	428,424 W5	429,425 W5	430,426 W5	431,427 W5	432,428 W5	433,429 W5	434,430 W5	435,431 W5	436,432 W5	437,433 W5	438,434 W5	439,435 W5	440,436 W5	441,437 W5	442,438 W5	443,439 W5	444,440 W5	445,441 W5	446,442 W5	447,443 W5	448,444 W5	449,445 W5	450,446 W5	451,447 W5	452,448 W5	453,449 W5	454,450 W5	455,451 W5	456,452 W5	457,453 W5	458,454 W5	459,455 W5	460,456 W5	461,457 W5	462,458 W5	463,459 W5	464,460 W5	465,461 W5	466,462 W5	467,463 W5	468,464 W5	469,465 W5	470,466 W5	471,467 W5	472,468 W5	473,469 W5	474,470 W5	475,471 W5	476,472 W5	477,473 W5	478,474 W5	479,475 W5	480,476 W5	481,477 W5	482,478 W5	483,479 W5	484,480 W5	485,481 W5	486,482 W5	487,483 W5	488,484 W5	489,485 W5	490,486 W5	491,487 W5	492,488 W5	493,489 W5	494,490 W5	495,491 W5	496,492 W5	497,493 W5	498,494 W5	499,495 W5	500,496 W5	501,497 W5	502,498 W5	503,499 W5	504,500 W5	505,501 W5	506,502 W5	507,503 W5	508,504 W5	509,505 W5	510,506 W5	511,507 W5	512,508 W5	513,509 W5	514,510 W5	515,511 W5	516,512 W5	517,513 W5	518,514 W5	519,515 W5	520,516 W5	521,517 W5	522,518 W5	523,519 W5	524,520 W5	525,521 W5	526,522 W5	527,523 W5	528,524 W5	529,525 W5	530,526 W5	531,527 W5	532,528 W5	533,529 W5	534,530 W5	535,531 W5	536,532 W5	537,533 W5	538,534 W5	539,535 W5	540,536 W5	541,537 W5	542,538 W5	543,539 W5	544,540 W5	545,541 W5	546,542 W5	547,543 W5	548,544 W5	549,545 W5	550,546 W5	551,547 W5	552,548 W5	553,549 W5	554,550 W5	555,551 W5	556,552 W5	557,553 W5	558,554 W5	559,555 W5	560,556 W5	561,557 W5	562,558 W5	563,559 W5	564,560 W5	565,561 W5	566,562 W5	567,563 W5	568,564 W5	569,565 W5	570,566 W5	571,567 W5	572,568 W5	573,569 W5	574,570 W5	575,571 W5	576,572 W5	577,573 W5	578,574 W5	579,575 W5	580,576 W5	581,577 W5	582,578 W5	583,579 W5	584,580 W5	585,581 W5	586,582 W5	587,583 W5	588,584 W5	589,585 W5	590,586 W5	591,587 W5	592,588 W5	593,589 W5	594,590 W5	595,591 W5	596,592 W5	597,593 W5	598,594 W5	599,595 W5	600,596 W5	601,597 W5	602,598 W5	603,599 W5	604,600 W5	605,601 W5	606,602 W5	607,603 W5	608,604 W5	609,605 W5	610,606 W5	611,607 W5	612,608 W5	613,609 W5	614,610 W5	615,611 W5	616,612 W5	617,613 W5	618,614 W5	619,615 W5	620,616 W5	621,617 W5	622,618 W5	623,619 W5	624,620 W5	625,621 W5	626,622 W5	627,623 W5	628,624 W5	629,625 W5	630,626 W5	631,627 W5	632,628 W5	633,629 W5	634,630 W5	635,631 W5	636,632 W5	637,633 W5	638,634 W5	639,635 W5	640,636 W5	641,637 W5	642,638 W5	643,639 W5	644,640 W5	645,641 W5	646,642 W5	647,643 W5	648,644 W5	649,645 W5	650,646 W5	651,647 W5	652,648 W5	653,649 W5	654,650 W5	655,651 W5	656,652 W5	657,653 W5	658,654 W5	659,655 W5	660,656 W5	661,657 W5	662,658 W5	663,659 W5	664,660 W5	665,661 W5	666,662 W5	667,663 W5	668,664 W5	669,665 W5	670,666 W5	671,667 W5	672,668 W5	673,669 W5	674,670 W5	675,671 W5	676,672 W5	677,673 W5	678,674 W5	679,675 W5	680,676 W5	681,677 W5	682,678 W5	683,679 W5	684,680 W5	685,681 W5	686,682 W5	687,683 W5	688,684 W5	689,685 W5	690,686 W5	691,687 W5	692,688 W5	693,689 W5	694,690 W5	695,691 W5	696,692 W5	697,693 W5	698,694 W5	699,695 W5	700,696 W5	701,697 W5	702,698 W5	703,699 W5	704,700 W5	705,701 W5	706,702 W5	707,703 W5	708,704 W5	709,705 W5	710,706 W5	711,707 W5	712,708 W5	713,709 W5	714,710 W5	715,711 W5	716,712 W5	717,713 W5	718,714 W5	719,715 W5	720,716 W5	721,717 W5	722,718 W5	723,719 W5	724,720 W5	725,721 W5	726,722 W5	727,723 W5	728,724 W5	729,725 W5	730,726 W5	731,727 W5	732,728 W5	733,729 W5	734,730 W5	735,731 W5	736,732 W5	737,733 W5	738,734 W5	739,735 W5	740,736 W5	741,737 W5	742,738 W5	743,739 W5	744,740 W5	745,741 W5	746,742 W5	747,743 W5	748,744 W5	749,745 W5	750,746 W5	751,747 W5	752,748 W5	753,749 W5	754,750 W5	755,751 W5	756,752 W5	757,753 W5	758,754 W5	759,755 W5	760,756 W5	761,757 W5	762,758 W5	763,759 W5	764,760 W5	765,761 W5	766,762 W5	767,763 W5	768,764 W5	769,765 W5	770,766 W5	771,767 W5	772,768 W5	773,769 W5	774,770 W5	775,771 W5	776,772 W5	777,773 W5	778,774 W5	779,775 W5	780,776 W5	781,777 W5	782,778 W5	783,779 W5	784,780 W5	785,781 W5	786,782 W5	787,783 W5	788,784 W5	789,785 W5	790,786 W5	791,787 W5	792,788 W5	793,789 W5	794,790 W5	795,791 W5	796,792 W5	797,793 W5	798,794 W5	799,795 W5	800,796 W5	801,797 W5	802,798 W5	803,799 W5	804,800 W5	805,801 W5	806,802 W5	807,803 W5	808,804 W5	809,805 W5	810,806 W5	811,807 W5	812,808 W5	813,809 W5	814,810 W5	815,811 W5	816,812 W5	817,813 W5	818,814 W5	819,815 W5	820,816 W5	821,817 W5	822,818 W5	823,819 W5	824,820 W5	825,821 W5	826,822 W5	827,823 W5	828,824 W5	829,825 W5	830,826 W5	831,827 W5	832,828 W5	833,829 W5	834,830 W5	835,831 W5	836,832 W5	837,833 W5	838,834 W5	839,835 W5	840,836 W5	841,837 W5	842,838 W5	843,839 W5	844,840 W
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Table 3. The synecological analysis of the parasitoid species in the period 1979-82.

Species	Abundance	Dominance	Constancy	Index of ecological significance
<i>Diadegma chrysosticta</i>	792	17.11 D5	88 C4	15.05 W5
<i>Diadegma fenestralis</i>	723	15.62 D5	92 C4	14.37 W5
<i>Diadegma armillata</i>	267	2.77 D4	96 C4	5.53 W4
<i>Diadromus collaris</i>	192	4.15 D3	80 C4	3.32 W3
<i>Diadromus cerophaga</i>	149	3.22 D3	68 C3	2.15 W3
<i>Diadegma subtilicornis</i>	98	2.12 D3	52 C3	1.10 W3
<i>Diadegma tibialis</i>	87	1.88 D2	60 C3	1.12 W3
<i>Apanteles fuliginosus</i>	74	1.60 D2	68 C3	1.08 W3
<i>Diadegma vestigialis</i>	67	1.45 D2	48 C2	0.69 W2
<i>Diadromus ustulatus</i>	52	1.52 D2	40 C2	0.44 W2
<i>Diadegma trochanterata</i>	36	0.78 D2	36 C2	0.28 W2
<i>Diadegma gibbula</i>	24	0.52 D1	8 C1	0.04 W1
<i>Phaeogenes ischiomelinus</i>	20	0.43 D1	40 C2	0.17 W2
<i>Dicaelotus parvulus</i>	18	0.39 D1	28 C2	0.10 W2
<i>Diadegma interrupta</i>	10	0.22 D1	28 C2	0.06 W1
<i>Diadegma gracilis</i>	9	0.19 D1	16 C1	0.03 W1
<i>Itoplectis alternans</i>	8	0.70 D1	28 C2	0.19 W2
<i>Itoplectis viduata</i>	7	0.15 D1	28 C2	0.04 W1
<i>Diadegma holopyga</i>	7	0.15 D1	24 C1	0.03 W1
<i>Diadegma monospila</i>	6	0.13 D1	20 C1	0.02 W1
<i>Hyposoter ebeninus</i>	2	0.04 D1	8 C1	0.003 W1
<i>Itoplectis tunetanus</i>	1	0.02 D1	4 C1	0.0008 W1
<i>Apanteles ruficrus</i>	1	0.02 D1	4 C1	0.0008 W1
<i>Apanteles rubecula</i>	1	0.02 D1	4 C1	0.0008 W1

Table 4. The synecological analysis of the parasitoid species in the year 1990.

Species	Abundance	Dominance	Constancy	Index of ecological significance
<i>Diadegma fenestralis</i>	979	32.89 D5	100 C4	32.89 W5
<i>Diadegma chrysosticta</i>	375	12.60 D5	71 C3	8.94 W4
<i>Diadegma armillata</i>	323	10.85 D5	78 C4	8.96 W4
<i>Diadromus subtilicornis</i>	180	6.04 D4	57 C3	3.44 W3
<i>Diadromus collaris</i>	142	4.77 D3	57 C3	2.71 W3
<i>Diadegma vestigialis</i>	50	1.68 D2	57 C3	0.95 W2
<i>Diadegma cerophaga</i>	45	1.57 D2	42 C2	0.65 W2
<i>Apanteles fuliginosus</i>	43	1.44 D2	42 C2	0.60 W2
<i>Diadegma tibialis</i>	21	0.70 D1	50 C2	0.35 W2
<i>Diadromus ustulatus</i>	12	0.40 D1	35 C2	0.14 W2
<i>Diadegma trochanterata</i>	9	0.30 D1	35 C2	0.10 W2
<i>Diadegma holopyga</i>	5	0.16 D1	28 C2	0.04 W1
<i>Diadegma gibbula</i>	4	0.12 D1	21 C1	0.02 W1
<i>Diadegma gracilis</i>	4	0.12 D1	21 C1	0.02 W1
<i>Itoplectis viduata</i>	2	0.06 D1	14 C1	0.008 W1
<i>Itoplectis alternans</i>	2	0.06 D1	14 C1	0.008 W1
<i>Diadegma monospila</i>	2	0.06 D1	14 C1	0.008 W1
<i>Diadegma interrupta</i>	2	0.06 D1	14 C1	0.008 W1
<i>Apanteles ruficrus</i>	1	0.03 D1	7 C1	0.002 W1
<i>Apanteles rubecula</i>	1	0.03 D1	7 C1	0.002 W1

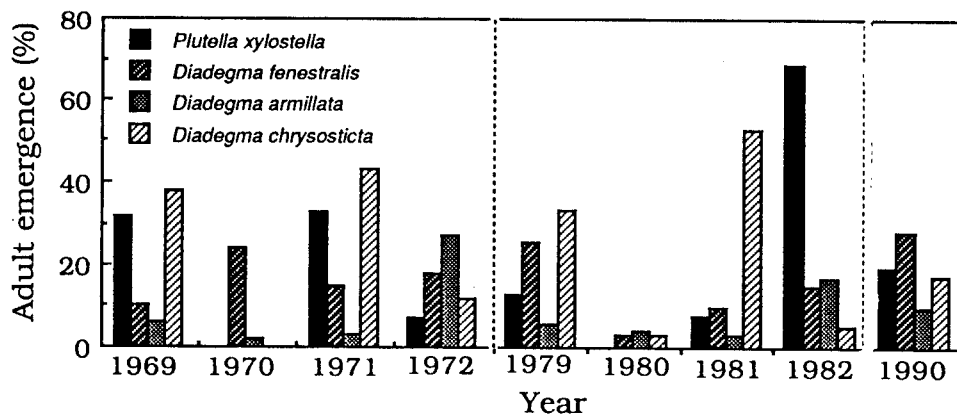


Fig. 2. Population dynamics of DBM and its major parasitoids during 1969-72, 1979-82 and 1990 at Adjudu Vechi.

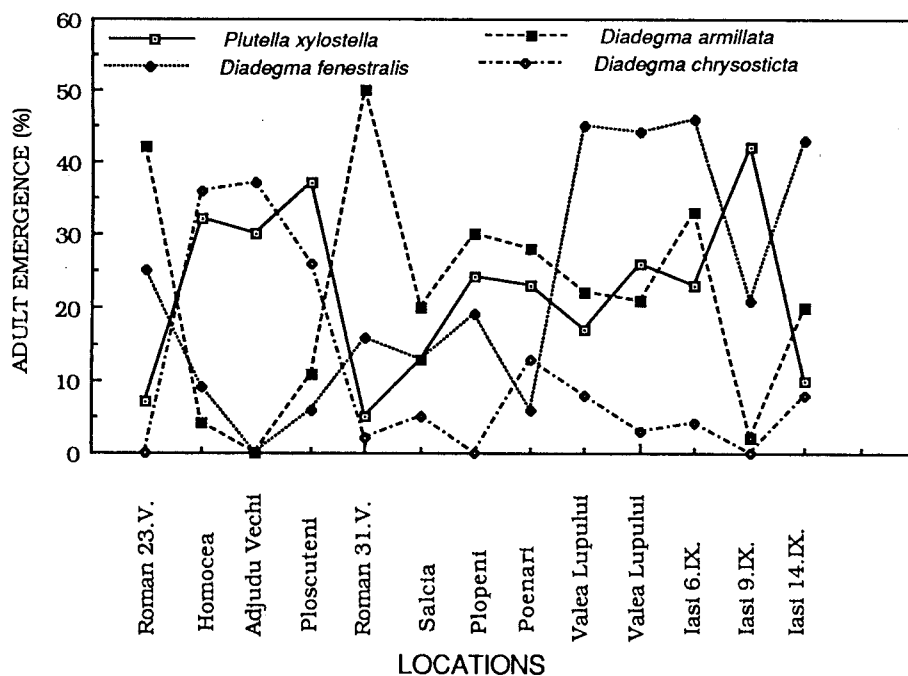


Fig. 3. Population dynamics of DBM and its major parasitoids at various locations during 1969.

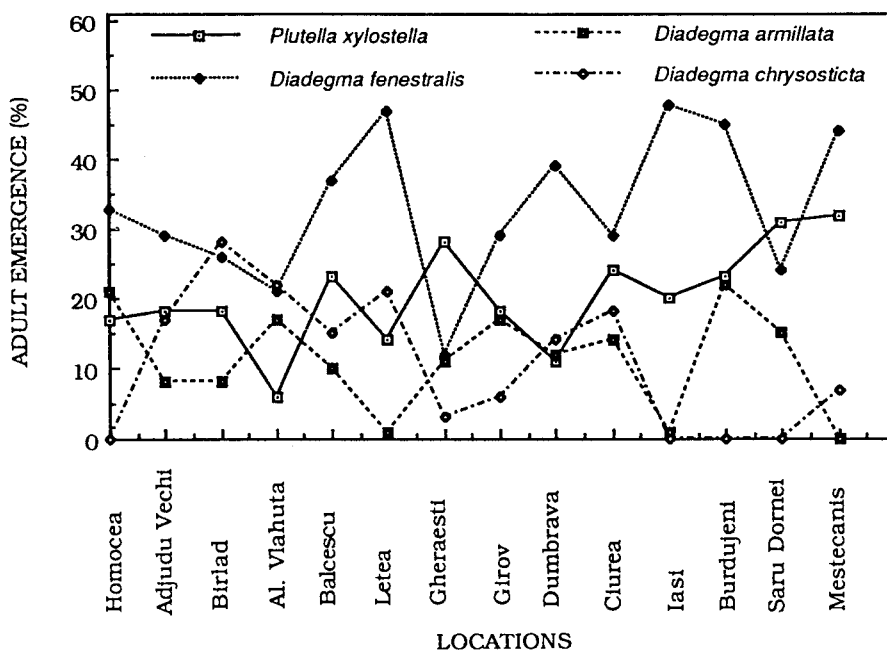


Fig. 4. Population dynamics of DBM and its major parasitoids at various locations during 1990.

over 95%, were parasitized. In these circumstances, treatment with insecticides is not justified, and adversely affects beneficial fauna with unpredictable consequences.

To combat pests we must know precisely the activity of the parasitoid and predatory species which limit pest populations. It is important that our interventions in natural ecosystems be done on the basis of thorough biocenotic data. Our intervention must be made in such a way that it does not affect the beneficial fauna. Otherwise we can provoke unpredictable disturbances in the biological equilibrium.

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