

ALTICA OF ISRAEL (COLEOPTERA: CHRYSOMELIDAE: ALTICINAE)

DAVID G. FURTH

*Department of Entomology, Faculty of Agriculture
Hebrew University of Jerusalem, Rehovot, Israel*

ABSTRACT

The validity and correct usage of the name *Altica* (Alticinae) rather than *Haltica* (Halticinae) is explained. Some general discussion of the zoogeography of *Altica* is given, especially for the six Israeli species that have affinities mostly to the Euro-Siberian, some to Mediterranean (East), and little to Irano-Turanian subregions of the Palearctic. The host plant family relationships of the genus *Altica* are reviewed. The distribution in general and within Israel is given for the six species found there as well as for two species expected to be found. *Altica ancycensis* Weise and *A. impressicollis* (Reiche) are new records in Israel and *A. jarmilae* Král was recently described including Israeli paratypes collected by this author. The host plants are listed for all species from the literature as well as hosts found by the author in Israel. A potential special type of Batesian mimicry of *Altica* species by their pentatomid bug predator, *Zicrona coerulea* (L.), is discussed. The biology and biogeography of *A. bicarinata* (Kutschera) and its host *Rubus sanctus* Schreb. are given.

INTRODUCTION

The genus *Altica* is the type genus of the Flea Beetles (Alticinae), the largest subfamily of the Leaf Beetles (Chrysomelidae). It is a widespread genus that is best represented in the Neotropical Region, well represented in the Nearctic Region, with somewhat less in the Palearctic, and a significantly smaller number of species approximately equally represented in the tropics of Africa and the Oriental-Australian Region (Heikertinger and Csiki, 1940). However, *Altica* is probably poorly known in most areas, except possibly in the Palearctic and to a lesser degree in the Nearctic, because it is taxonomically one of the most difficult genera of Flea Beetles. This is because all species are basically the same color (metallic blue-green-bronze) with very few reliable external distinguishing morphological features; therefore, it is almost imperative to examine the male genitalia (aedeagus) in order to determine the species. Unlike in some other alticine genera, female spermathecae are not useful for species separation. As with most genera of Alticinae the food plant information can also be useful (Furth,

1979) but for most species of *Altica* this information is unknown or not included with specimens to be determined.

Because of the long history of entomological exploration and research in the Palearctic Region, like with many taxa, the *Altica* fauna is more completely known there than in other regions. There are many regional works on Alticinae that include biological information, descriptions, and keys to Palearctic *Altica* (as well as many isolated descriptions and information); however, only a few are of real practical use (Kevan, 1962; Král, 1964-1979; Mohr, 1966).

Despite the long history of the study of Flea Beetle taxonomy and biology, there has been a long-lived confusion as to the correct spelling of the subfamily name – based on the type genus *Altica*. Even at present many workers, including Flea Beetle specialists and other coleopterists, have used the name Halticinae (*Haltica*). While this may seem like a trivial point to some people, I believe that for the sake of congruity the correct nomenclature should be used by all, especially those working with Flea Beetles. Heikertinger (1940) in his catalogue uses Halticinae and as a footnote under the genus *Haltica* he explains that *Altica* is an incorrect transcription (to Latin from the ancient Greek, *haltikos*); therefore, he uses *Haltica*. *Altica* was first used by Geoffroy (1762, 1764) invalidly in a non-binomial system. *Altica* was also cited by Müller (1764); however, this citation is invalid because it does not include any species names. According to Article 69 a ii (International Code of Zoological Nomenclature, adopted by the Fifteenth International Congress of Zoology, 1958, published in 1961), the first author to use the generic name in combination with specific names defines the genus (Silfverberg, 1978). Thus, Fabricius (1775) was the first to use *Altica* validly and this genus name must be attributed to him. *Altica* was subsequently used by several authors at the end of the Eighteenth Century before the first use of *Haltica* by Koch (1803). Heikertinger (1940), preceding the adoption of the International Code of Zoological Nomenclature, attempted to correct what he considered to be an error in the transliteration (via Geoffroy) of the Greek “haltikos” to “altica”. However, employing the International Code of Zoological Nomenclature as mentioned above (Article 69 a ii) and that relative to original spelling and transliteration (Article 32 a ii); the valid name is *Altica* Fabricius, 1775 (Alticinae). Although most modern workers have realized this correct use of *Altica* (Wilcox, 1976; Král, 1964-1979; Scherer, 1969), some have still persisted in using the invalid name of *Haltica*, Halticinae (Mohr, 1966; Warchalowski, 1976a; etc.). Hopefully the preceding text will help to rectify the incongruity and misspelling of the type genus of the Flea Beetles (Alticinae).

Bodenheimer (1937) listed five species of *Altica* in Palestine but only three of these were correct identifications and in fact exist there. There are six species currently known from Israel with at least two more described species that may some day be found there. The recorded distribution and hosts for these eight species are given below as well as the distribution and hosts in Israel (six species). Also there is some discussion of zoogeography, host plant relationships, and biological notes relevant to the *Altica* of Israel.

ISRAELI SPECIES OF *ALTICA*

In this section, under distribution range, all records are from Heikertinger and Csiki (1940) unless otherwise indicated; also here the zoogeographic affinity and predicted distribution are given. The areas mentioned under distribution in Israel refer to the map of geographical areas of Israel and Sinai (see Furth, 1980a).

In the section of host plants, the range of collection dates in Israel are also given.

Altica ancyrensis Weise

Distribution

Range: Turkey; Israel (new). A Euro-Siberian element; probably also in Syria, Lebanon, and Jordan. Israel is evidently the only record since the original description in 1897 from North Turkey.

Israel: Golan Heights; Upper Galilee; Yisráel Valley.

Host

No previous record; in Israel on *Epilobium hirsutum*; main season 8 August to 18 November, also recorded sporadically from 22 February until 5 June.

Altica bicarinata (Kutschera)

Altica ciliciensis Weise

Distribution

Range: Turkey; Syria; Lebanon; Cyprus; Israel; Egypt. An Eastern Mediterranean element; probably also in Jordan.

Israel: S. Coastal Plain; Judean Foothills; Judean Mountains; Samaria; Jordan Valley; and all areas until the Golan Heights and Mt. Hermon.

Host

Recorded: *Rubus* sp. (Tomov and Gruev, 1975; Král, 1979)

Israel: *Rubus sanctus* Schreb. (= *sanguineus* Frivaldszk.) (Král, 1979); in Israel all months, especially March to July.

Remarks

In my Ph.D. thesis (Furth, 1976)* I recorded *A. ciliciensis* Weise as a synonym of *A. bicarinata* based on morphological characters (including male aedeagus) and biology (specimens from the British Museum of Natural History from Cyprus, recorded on *Rubus* sp., see also Georghiou, 1977); subsequently, I also collected this species on *Rubus* in Cyprus in 1978. Král came to the same conclusions concurrently and pub-

*Furth, D.G. 1976. Alticinae of Israel, with special reference to the systematic, zoogeographic, and host plant relationships of *Phyllotreta* and *Longitarsus* (Coleoptera: Chrysomelidae). Unpublished Ph.D. dissertation, Cornell University.

lished this new synonymy (Král, 1979). In this same paper Král recorded *Rubus* sp. as a host from Cyprus and *Rubus sanguineus* in Israel from specimens of *A. bicarinata* that I had sent to him.

Altica deserticola Weise

Distribution

Range: USSR (SE Russia, Astrachan, Ural Prov., Caucasus, Armenia, Turkestan, Siberia); Mongolia; China and Taiwan (Kimoto, 1971); Turkey; Iran; Afghanistan (Lopatin, 1963); Syria; Iraq; Jordan; Israel. A Palearctic element (Euro-Siberian/Iranoturanian).

Israel: Upper Galilee; Jordan Valley; Dead Sea. Always from localities in the Rift Valley.

Host

Unknown. Several miscellaneous host plants are recorded sporadically in the literature but none is consistent. The one thing that they all seem to have in common is their proximity to springs or rivers. All locations in Israel are permanently wet places near springs, streams, the Jordan River, or the Sea of Galilee (all in the Rift Valley). I have searched for this beetle and its host many times without success in recorded locations and during its recorded adult season (records are from specimens in the collections of Tel Aviv University and Beit Gordon, Kibbutz Deganya A). Its host is certainly not *Epilobium* or *Rubus* as with the other Israeli *Altica*. It has been recorded on *Prosopis farcta* (Mimosaceae) (Tel Aviv University collection, Department of Zoology) but this is apparently only coincidental. One plant present in most of the locations that may be its potential host plant is *Glycyrrhiza glabra* L. (Papilionaceae). This plant is recorded in the literature (Shapiro, 1970) and in Israel as a host (collection of the Division of Entomology, Agricultural Research Organization, Ilanot). I have found extensive *Altica*-like damage on the leaves of this plant, but never larvae or adults. In Israel this beetle is recorded from 24 April until 9 September (mostly in June to August).

Altica impressicollis (Reiche)

Distribution

Range: Germany (Mohr, 1975); Poland (Warchalowski, 1976a); Austria; Hungary; Yugoslavia; Bulgaria (Warchalowski, 1974); Corsica; Italy (including Sardinia and Sicily); USSR (Caucasus; Transcaspia); Albania; Turkey; Iran; Syria; Israel (new). A Euro-Siberian/East Mediterranean element.

Israel: S. Coastal Plain; Judean Foothills; Judean Mountains; Samaria; Jordan Valley; all areas until the Golan Heights and Mt. Hermon.

Host

Recorded: *Eupatorium cannabinum* (Mohr, 1966); *Epilobium hirsutum* (Král, 1966); *Lythrum salicariae* (Nonveller, 1959).

Israel: *Epilobium hirsutum*; in Israel from 8 March until 13 August and 15 October.

Altica jarmilae Král

Distribution

Range: Bulgaria; Greece; Turkey; USSR (Georgia); Israel (all records from Král, 1979). A Euro-Siberian/East Mediterranean element; probably also in Syria, Lebanon, and Jordan. Král (1979) lists Syria "Kaifa, Reitter", but this is Haifa, Israel.
Israel: Mt. Hermon (1000 m); Golan Heights.

Host

Recorded: *Epilobium hirsutum*; *E. tetragonum*.

Israel: *Epilobium hirsutum*; *E. tournefortii* Michal. Found from 17 April until 27 June, and 24 Oct.

Altica oleracea (L.)

Distribution

Range: all Europe; Balkans; Turkey; Iran; USSR (Caucasus, Turkestan); China; Japan (Kimoto, 1966); Korea (Warchalowski, 1969); Israel. A Euro-Siberian/Irano-Turanian/Circum-Mediterranean (= Palearctic) element; probably also in Syria, Lebanon, and Jordan.

Israel: Judean Foothills; Judean Mountains; Samaria; Jordan Valley; all areas to the north, except Coastal Plains and Mt. Hermon.

Host

Recorded: Heikertinger (1925): *Epilobium* 5 spp.; *Oenothera*; *Lythrum salicariae*; *Polygonum*; in hunger (= stress) situations, Cruciferae: *Sisymbrium*; *Sinapis arvensis*; *Brassica rapae*; *Raphanus sativus*; *Casella bursa-pastoris*; and several others from other families. Oligophagous, preferring Onagraceae.

Israel: *Epilobium hirsutum*; in Israel from 21 February until 18 October.

Altica carduorum (Guérin-Meneville)

Distribution

Range: S. Europe north to mid-France and SW Germany, east to Balkans; Greece; Turkey (Tomov and Gruev, 1975). Not yet recorded from Iran or Israel, but a potential immigrant to the SE Mediterranean. Records from Cyprus (on bramble) (Georghiou, 1977) are most certainly misidentified *A. bicarinata*. A Circum-Mediterranean/Euro-Siberian element.

Host

Recorded: *Cirsium* (Mohr, 1966); *Carduus* (Heikertinger, 1925). This species has been used for biological control of *Cirsium arvense* in Canada, but without much success (Peschken *et al.*, 1970; Zwölfer, 1969).

Altica tamaricis Schrank

Distribution

Range: all Europe, west to Spain, east to all Balkans; Turkey; USSR (Siberia, Caucasus, Uzbek); Afghanistan (Lopatin, 1963); Mongolia; China (Manchuria); Japan; Iraq; Syria (?). A Euro-Siberian/Irano-Turanian element; a possible discovery or immigrant into Israel.

Host

Recorded: *Tamarix* (Zocchi, 1971; Tomov and Gruev, 1975); *Myricaria* (Tamaricaceae), *Hippophae* (Eleagnaceae), *Salix*, and *Populus* (Mohr, 1966).

DISCUSSION

Zoogeography:

As mentioned above the genus *Altica* is relatively poorly represented in the Old World (Eastern Hemisphere), especially in the Old World tropics. This may be at least partially due to the under-exploration of the Old World tropics; however, more likely this present-day dominance in the New World (Western Hemisphere) reflects the historical biogeography of *Altica* or its ancestors. Some might say that based on contemporary distribution patterns the origin of *Altica* was in the New World, possibly in the New World tropics (Neotropics), having subsequently spread to the Old World. Scherer (in litt.) believes that *Altica* or its ancestors may have originated in Africa before its separation from South America in the Jurassic and, thus, may have entered the New World. There is Tertiary fossil evidence of species of *Altica* from both Old and New World (France and Colorado) (Piton, 1940 and Wickham, 1914, respectively); however, not enough is yet known about the evolution of *Altica* or its relatives in order to be certain of its origin.

The apparent biogeographical affinities of *Altica* in Israel (Middle East) are quite different from *Phyllotreta* and *Longitarsus* (Furth, 1979, 1980a, 1980b). *Altica* completely lacks any affinity to the Eremian (Sahara-Arabian) subregion of the Palearctic which is very prominent in the *Phyllotreta* of this area and it also lacks the dominance of the Mediterranean subregion prominent in both *Phyllotreta* and *Longitarsus*. There is also no indication of affinity to Tropical Africa (Ethiopian Region). The same biogeographical regional terminology and percentage analysis of zoogeographical affinity (based on recorded distribution and personal field data of ecological limiting factors) are used here as in my previous studies of *Phyllotreta* and *Longitarsus* (Furth, 1979, 1980a, 1980b). It is apparent that the primary affinity of Israeli *Altica* is to the Euro-Siberian subregion (53%) with a significant Mediterranean affinity (35%), mostly East Mediterranean, and rather weak Irano-Turanian (central Asia) affinity (12%). Two species are restricted to a single biogeographical subregion of the Palearctic (*A. ancycrensis* and *A. bicarinata*) but there are no truly endemic species in the Middle East. Contrastingly, one species (*A. oleracea*) is extremely widespread throughout most of the Palearctic and is less useful in analysis of the biogeographical affinity of Israeli *Altica*.

The dominance of the Euro-Siberian affinity is very interesting since it may indicate that this northern part of Palearctic affinity is a relatively recent invasion into the Middle East that could only have occurred after the closing of the great marine barrier, the Tethys Sea, in Pliocene-Pleistocene times. This, along with the absence of Ethiopian or Eremian affinities, may also indicate that *Altica* spread into the Middle East from Palearctic Asia or Europe and having an even earlier origin in the New World.

One particular biogeographical pattern is worthy of mention. The Raspberry Flea Beetle, *Altica bicarinata*, is also known from Cairo, Egypt (specimens in the Museum G. Frey, Munich) yet its host *Rubus sanctus* does not exist in the Judean, Negev, or North Sinai Deserts to the south and west (Zohary *et al.*, 1980 recorded *R. sanctus* in North Sinai based on a misunderstanding from the literature). However, *R. sanctus* is known, although extremely rare, from the southern Sinai Mountains (Tackholm, 1974; and a specimen in the Herbarium of the Hebrew University of Jerusalem – Wadi Tubuq, 1500 m, 1971, growing naturally near water, leg. A. Danin). *Rubus sanctus* (= *sanguineus*) is distributed throughout middle Europe, all Circum-Mediterranean countries (including all North Africa) and the Canary Islands, and the Middle East until the western Himalayas. *Rubus sanctus* grows near and along fresh water canals, rivers, etc. or areas where there is extensive underground water near the surface. This beetle is presumably specific to *R. sanctus* but may also be able to feed on other species of *Rubus*. Apparently the records of this beetle from Cairo were also feeding on *R. sanctus* along the Nile or its tributaries. However, the question remains – how did the beetle get there? – since the desert barrier between northern Israel and the Nile River Valley is a considerable one, not easily crossed by such a beetle. Dispersal to Egypt by flight or by wind seems very unlikely considering the distance and wind directions. It is also improbable that there was any intentional transport of the beetle and/or its Raspberry host by humans because Raspberry is not cultivated in the Middle East. Accidental transport also seems improbable because even the adult stage of the beetle would probably not survive such a distance without desiccation. The direction of spread is almost certainly from east to west especially since the center of distribution of *A. bicarinata* is distinctly in the more mesic (lush) areas of the eastern end of the Mediterranean (southern Turkey, Lebanon, northern Israel). Perhaps the most reasonable explanation for this disjunction is that the western-most population in Egypt is a relictual one from a period when the distribution of *Rubus sanctus* was more extensive across what is presently a desert region, i.e. northern Sinai. Shmida (1977) discusses many plants relicts in the northern Sinai that were more widespread in the late Pleistocene times (13-35,000 Y.P.B.) when the climate was 1-2°C cooler and with 300-400 mm/year more precipitation. Shmida also mentions that other workers concluded that even earlier in the Pleistocene the temperature was 4-5°C cooler than today and usually with more precipitation. The rare and isolated presence of *R. sanctus* in the well-watered cool climate of the high southern Sinai Mountains is certainly relictual and provides further evidence for the theory that in Pleistocene times *Rubus sanctus* and *Altica bicarinata* may have been continuously distributed from Israel to Egypt. Because of its heavy reliance on freshwater sources, *Rubus* may have disappeared from the northern Sinai early in the desertification process, late in the Pleistocene, without leaving any present-day relictual populations between the Nile and northern Israel.

Host Plants

The host plant families of *Altica* are more diverse than *Phyllotreta* (three host families) (Furth, 1979) or for *Longitarsus* (seven host families) (Furth, 1980b). Nevertheless, there is somewhat of a pattern with a few families dominating in both the Old and New World as hosts for *Altica*. In a survey of some of the literature containing host information for Palearctic *Altica*, there are nine plant families listed as hosts (Mohr, 1966 and Král, 1964-1979). A similar survey of North American (Nearctic) *Altica* (Wilcox, 1979) reveals at least another six plant families (three of which are annuals and questionably true food plant families). Most of these host families are perennials and, in fact, many are woody perennials (trees). This is rather unusual because most Flea Beetle genera have annual or non-woody perennial hosts. Apparently in several cases an *Altica* species is able to feed on trees in two or more families, e.g. *A. quercetorum* normally on *Quercus* (Fagaceae) has been often recorded on *Salix* (Salicaceae) and *A. tamaricis* normally on *Tamarix* (Tamaricaceae) has been recorded on *Salix* (Mohr, 1966). Likewise, in North America, *A. ulmi* Woods normally on *Ulmus* (Ulmaceae) has been found feeding on *Tilia* (Tiliaceae) (Wilcox, 1979). Little, if anything, is known about *Altica* hosts in the Old and New World tropics, but host relationships presumably show some similar trends as in the temperate zones (Holarctic) (Scherer, 1969; Samuelson, 1973; Furth, unpublished data).

There are five primary host families for Holarctic species of *Altica*: Onagraceae; Rosaceae; Ericaceae; Corylaceae; and Cornaceae. All of these families are hosts for both Palearctic and Nearctic species of *Altica*. This is also true for Vitaceae; *A. chalybea* Ill. and *A. ampelophaga* (Guérin-Men.) are pests on grapes (*Vitis vinifera* L.) in North America and in Europe, respectively. Onagraceae (*Epilobium*, *Oenothera*) is clearly the dominant host plant family for *Altica* with Rosaceae (*Rosa*, *Rubus*, *Fragaria*, etc.) evidently the second largest. The fact that there are *Altica* species counterparts, from a variety of host plant families in both the Palearctic and Nearctic Regions (Old and New World), may indicate common ancestral lineage. Thus, it is not surprising that in Israel, where there are few of woody perennial species relative to Europe, North America or the moist tropics, there are only a few species of *Altica* which feed on the two most common *Altica*-host families — Onagraceae (*Epilobium*) and Rosaceae (*Rubus*). It is worth noting that some species that apparently prefer Onagraceae have also been recorded on Rosaceae, e.g. *A. oleracea* on Strawberry (*Fragaria*) (Nonveiller, 1959). It is very important to record host plant information for species of *Altica* because it may be one of the most useful characters in their determination.

Biology

The exact life cycle and number of generations are not known for the Israeli *Altica*; however, the biology of one of them, *A. oleracea*, is well known in Europe (Heikertinger, 1940). In 1974 the most common Israeli *Altica*, *A. bicarinata*, was reared for one generation from two localities (Tel Aviv and Wadi Faria in Samaria) and certain life cycle information was obtained. In both of the above localities the first copulating adults were brought from the field during the first week of March. The orange eggs were laid immediately, singly or in small groups, usually on the underside of the *Rubus* leaves. The first instar larvae hatched in approximately 10-12 days and began to feed on both leaf surfaces. The larvae skeletonize the leaves sometimes to

such an extent that large areas of the *Rubus* bushes appear burned or diseased. This was especially evident in April and May in the Baniyas and Huleh Nature Preserves and W. Faria where large, but apparently localized, populations exist. As mentioned above, adults are often found feeding together with the larvae. The larvae feed for approximately one month and then pupate in the soil beneath the Raspberry bushes; pupation lasts about one week. Therefore, the entire life cycle lasts from 6-7 weeks. It seems evident that there are at least two and probably three generations of *A. bicarinata* per year in Israel. However, the first generation seems to produce the largest populations and sometimes in late April, after the emergence of the adults of the first generation, thousands of beetles can be seen in masses on a relatively small area of *Rubus*. It is doubtful whether any of the other five species of Israeli *Altica* have more than one generation per year, but not enough is known yet about their biology.

Altica bicarinata was tested for host plant range and preference with other plants in its host's family. In a caged situation, and evidently in nature, it always prefers its host, *Rubus sanctus* but if offered no choice it can and will feed on *Rubus tomentosus* Borkh. and *Rosa canina* L. and under no circumstances will it eat Apple (*Pyrus malus* (L.)). *A. bicarinata* has not yet been tested with Strawberry (*Fragaria chiloensis* Duchesne). In nature this beetle is very specific in its preference and is only found feeding on *Rubus sanctus*.

Predator Mimicry

Both the adults and larvae of *Altica* are external leaf feeders and the two stages can often be found in some abundance together on the same plant and even on the same leaves. There are more adults early in the season but all species collected by the author in Israel apparently have a considerable period of overlap of the adults and larvae; thus, apparently a sort of intra-specific competition for leaf surface. During this overlap period it is quite common to find nymphs or adults of a pentatomid bug predator, *Zicrona coerulea* (L.), feeding on the black larvae of the species of Israeli *Altica*. However, adults of this predatory bug have also been collected amongst populations of only adult *Altica* beetles; although to date they have not been observed feeding on adult beetles. Presumably this is because the adult *Altica* would jump away if approached by this predator. An interesting phenomenon exists in this relationship because the adult *Zicrona* predator is exactly the same color (metallic blue-green or bronze) as the adult *Altica* and only slightly larger in size. It may be possible for the "disguised" (mimicing) predator to surprise an adult *Altica* and paralyze it before the beetle can escape. Such a case would be an example of "aggressive mimicry" where a predator or parasite resembles its host (model) in order to approach it without exciting suspicion; thus, the selective agents are simultaneously the models (Rettenmeyer, 1970). The *Zicrona-Altica* mimicry is complexed by the probable fact that the predator apparently attacks mostly the larvae of *Altica*, yet mimics the adult stage. Imms (1964), however, mentions that in China *Zicrona coerulea* nymphs feed on larvae of *A. coerulea* Olivier and the adult bugs attack the adult beetles of that species. Throughout the European literature *Zicrona* is cited as a primary predator of *A. ampelophaga*, the grape vine pest, as well as of other *Altica* (Heikertinger and Csiki, 1940; Kerzhner and Yaczewski, 1967). *Zicrona* is also reported in the literature to prey on various other insects but none as consistently as species of *Altica*.

There may also be a case here for "Wasmannian mimicry" where resemblances facilitate a mimic living with its host (Rettenmeyer, 1970). However, since insect vision is usually poor, color pattern alone may not always be a sufficient "disguise" and a chemical mimicry may be necessary to permit co-existence of the model and mimic; this is somewhat dependent on their necessary proximity to each other (Rettenmeyer, 1970; Lindroth, 1971). A third possibility is the sort of Batesian mimicry mentioned by Lindroth (1971) for the carabid beetles (*Lebia*) which mimic the patterns and colors of Flea Beetles, presumably to avoid predation by birds that are unable to feed on the efficiently jumping Flea Beetle models (the larvae of the mimics presumably are parasitic on the beetle pupae). Lindroth showed that two Flea Beetle genera (including *Altica*) were not distasteful to birds and he reasoned that beetles perched on the leaves of their host would probably escape (by jumping) most bird predation. It is not known whether the *Zicrona* have their own chemical defenses as do many pentatomids or if they receive most of their protection, at least from birds, by mimicing the various species of *Altica*. *Zicrona* probably prey on their model's larvae and later in the season on other insects in the environs of the *Altica* population and its host plant. It seems most likely that this is a case of a type of Batesian mimicry similar to that shown by Lindroth (1971) rather than aggressive or Wasmannian mimicry.

It is suggested that *Zicrona*, while able to feed on a variety of insects if necessary, has evolved with species of *Altica* as its prey throughout its range and gains a distinct advantage through Batesian mimicry of adult *Altica* beetles so as to avoid bird predation. However, the *Zicrona-Altica* relationship requires further study.

Morphology

As mentioned in the Introduction, the most certain method for determination of species in the genus *Altica* is by the male genitalia (aedeagus). No figures of these are included here but they will be included in a future treatment of the Alticinae of Israel (Fauna Palaestina, Furth, in preparation). Meanwhile, the reader interested in determination of Israeli *Altica* is referred to the following references for descriptions and aedeagus figures of the six Israeli species: *ancyrensis* – Král, 1969; *bicarinata* – Král, 1979; *deserticola* – Oglobin, 1925, fig. 1; *impressicollis* – Mohr, 1966; *jarmilae* – Král, 1979; *oleracea* – Mohr, 1966.

The female spermathecae are of little use in *Altica* except for forming groups of species according to spermathecal morphology (Kevan, 1962; Furth, unpublished data). Preliminarily, the six Israeli species fall into three similarity groups according to the morphology of the spermatheca: a) *impressicollis*, *deserticola*, *oleracea*; b) *jarmilae*; c) *bicarinata*, *ancyrensis*. Further separation of the species is not possible with any accuracy. This will also be considered with accompanying figures in the volume of Alticinae of Israel in preparation.

There are very few external morphological characters which are generally useful in determining species of *Altica*. However, the frontal bossae or tubercles are very often useful characters. The shape of these tubercles and their position relative to each other and relative to the nasal carina are the important factors.

REFERENCES

- Bodenheimer, F.S. 1937. Prodrromus Faunae Palaestinae. *Mémoires de l'Institut d'Égypte*, 33:148-149.
- Fabricius, J.C. 1775. *Systema Entomologiae Insectorum*. Flensburgi et Lipsiae, pp. 94-122.
- Furth, D.G. 1979. Zoogeography and host plant ecology of the Alticinae of Israel, especially *Phyllotreta*; with descriptions of three new species (Coleoptera: Chrysomelidae). *Israel Journal of Zoology*, 28(1):1-37.
- Furth, D.G. 1980a. Zoogeography and host plants of *Longitarsus* in Israel, with descriptions of six new species (Coleoptera: Chrysomelidae). *Israel Journal of Entomology*, 13:79-124.
- Furth, D.G. 1980b. Wing polymorphism, host plant ecology, and biogeography of *Longitarsus* in Israel (Coleoptera: Chrysomelidae). *Israel Journal of Entomology*, 13:125-148.
- Geoffroy, E.L. 1762. Histoire abrégée des Insectes qui se trouvent aux environs de Paris. I. Paris, p. 1-523.
- Geoffroy, E.L. 1764. Histoire abrégée des insectes. Durand, Paris, Vol. 1, pp. 244-251.
- Georghiou, G.P. 1977. The insects and mites of Cyprus. Benaki Phytopathological Institute, Athens.
- Heikertinger, F. 1925. Resultate fünfzehnjähriger Untersuchungen über die Nahrungspflanzen einheimischen Halticinen. *Entomologische Blätter*, 21(2):90-92.
- Heikertinger, F. and E. Csiki. 1940. Coleopterorum Catalogus. W. Junk, S. Schenkling (Eds.), Chrysomelidae, Halticinae. Pars 166, pp. 1-336.
- Imms, A.D. 1964. A general textbook of Entomology. Ninth Edition (revised by O.W. Richards and R.G. Davies). Methuen and Co., Ltd., London. 886 pp.
- Kerzhner, I.M. and T.L. Yaczevski 1967. Hemiptera, Chapter 19. In: Bei-Bienko (Ed.), Keys to the insects of the European USSR, Vol. 1, pp. 851-1118. Israel Program for Scientific Translations, Jerusalem.
- Kevan, D.K. 1962. The British species of the genus *Haltica* Geoffroy (Col., Chrysomelidae). *The Entomologist's Monthly Magazine*, 98:189-196.
- Kimoto, S. 1966. A list of the Chrysomelidae collected by the scientific expedition of Kyoto University to Afghanistan in 1960 (Coleoptera). Results of the Kyoto University Scientific Expedition to the Karakoram and Hindukush, 1955. Vol. 8, pp. 217-220.
- Kimoto, S. 1971. Notes on the Chrysomelidae from Taiwan VI. *Entomological Review of Japan*, 23(2):73-87.
- Koch, J.D.W. 1803. Monographie der Flöhkäfer. *Entomologische Hefte*, 2(1):3-90.
- Král, J. 1964-1979. Zur Kenntnis der paläarktischen *Altica*-Arten. *Entomologische Blätter*. 1964, Part 1, 60:126-133. 1964, Part 2, 60:162-166. 1966, Part 3, 62:53-61. 1966, Part 4, 62:159-168. 1969, Part 5, 65:72-85. 1976, Part 6, 72:61-63. 1979, Part 7, 75:98-108.
- Lindroth, C.H. 1971. Disappearance as a protective factor. A supposed case of Batesian mimicry among beetles (Coleoptera: Carabidae and Chrysomelidae). *Entomologica Scandinavica* 2: 41-48, 1 Pl.
- Lopatin, I. 1963. Die Chrysomeliden (Coleoptera) Afghanistans auf Grund der Ergebnisse der Forschungsreise des Herrn. J. Klapperich in den Jahren 1952/53. *Annales Historico-Naturales Musei Nationalis Hungarici, Pars Zoologica*, 55:349-378.
- Mohr, K.-H. 1966. Chrysomelidae. In: Die Käfer Mitteleuropas. H. Freude, K. Harde, and G. Lohse (Eds.). Boeckle and Evers, Krefeld. Vol. 9, pp. 231-236.
- Mohr, K.-H. 1975. Zur Zoogeographie zweier im Gebiet der DDR vorkommender *Haltica* Arten (Coleoptera, Chrysomelidae, Halticinae). *Entomologische Nachrichten*, 19:15-19.
- Müller, O.F. 1764. *Fauna Insectorum Fridrichsdalina. Hafniae et Lipsiae*. xxiv + 96 pp.
- Nonveiller, G. 1959. Un cas d'apparition de *Haltica oleracea* L. sur le Fraisier avec de nouvelles données sur ses plantes-hôtes (Halticinae, Coleoptera), *Zastita Bilja*, 55:87-95.
- Oglobin, D.A. 1925. Einige neue *Haltica*-Formen aus der paläarktischen Region. *Revue Russe d'Entomologie*, 19(2):91-96.
- Peschken, D., H.A. Friesen, N.V. Tonks, and F.L. Banham. 1970. Releases of *Altica carduorum* (Chrysomelidae: Coleoptera) against the weed Canada Thistle (*Cirsium arvense*) in Canada. *Canadian Entomologist*, 102(3):264-271.
- Piton, L. 1940. Paléontologie du gisement éocène de Menat (Puy-de-Dôme). Thesis; Faculté de Sciences Clermont. 306 pp., 105 figs.

- Rettenmeyer, C.W. 1970. Insect mimicry. *Annual Review of Entomology*, 15:43-74.
- Samuelson, G.A. 1973. Alticinae of Oceania (Coleoptera: Chrysomelidae). *Pacific Insects Monograph*, 30:1-165.
- Scherer, G. 1969. Die Alticinae des indischen Subkontinentes (Coleoptera-Chrysomelidae). *Pacific Insects Monograph*, 22:1-251.
- Shapiro, D.S. 1970. A review of the Flea Beetles (Coleoptera, Chrysomelidae, Halticinae) of Dagestan and neighboring regions of the Caspian lowland. *Entomological Review*, 1969(2): 162-167.
- Shmida, A. 1977. Remarks on the palaeo-climates of Sinai based on the distribution patterns of relict plants. In: Qedem, vol. 7. Prehistoric investigations in Gebel Maghara, Northern Sinai. O. Bar-Yosef and J.L. Phillips (Eds.). Ahva Co-op Press, Jerusalem. pp. 36-41.
- Siffverberg, H. 1978. The coleopteran genera of Müller 1764. *Notulae Entomologicae*, 58:117-119.
- Tackholm, V. 1974. Student's flora of Egypt. Second edition. Cairo University, 727 pp.
- Tomov, V. and B. Gruev. 1975. Chrysomelidae (Coleoptera) collected by K.M. Guichard in Turkey, Greece, and Yugoslavia. *Travaux Scientifiques, Biologie*, 13(4):133-151.
- Warchalowski, A. 1969. Beitrag zur Kenntnis der koreanischen Halticinae (Coleoptera, Chrysomelidae). *Annales Zoologici*, 27(11):225-236.
- Warchalowski, A. 1974. Übersicht der Blattkäfer Bulgariens (Coleoptera, Chrysomelidae). *Polskie Pismo Entomologiczne*, 44:473-542.
- Warchalowski, A. 1976a. Biogeographische studien über die Blattkäfer der Pontischen Provinz (Coleoptera, Chrysomelidae). *Polskie Pismo Entomologiczne*, 46:29-94.
- Warchalowski, A. 1976b. *Haltica impressicollis* (Reiche, 1862), eine für Polen neue Flöhkäferart (Coleoptera, Chrysomelidae). *Polskie Pismo Entomologiczne*, 46:247-249.
- Wickham, H.F. 1914. New Miocene Coleoptera from Florissant. *Bulletin of the Museum of Comparative Zoology at Harvard College*, 58:423-494.
- Wilcox, J.A. 1975. Checklist of the beetles of Canada, United States, Mexico, Central America, and the West Indies. The Leaf Beetles. Family No. 104. Vol. 1(7):1-166 (Red Version). Biological Research Institute of America, Inc., Latham, N.Y.
- Wilcox, J.A. 1979. Leaf Beetle host plants in northeastern North America (Coleoptera: Chrysomelidae). World Natural History Publications, Kinderhook, N.Y. 30 pp.
- Zocchi, R. 1971. Contributo alla conoscenza dell'Entomofauna delle Tamerici in Italia. *Redia*, 52:33-129.
- Zohary, M., C.C. Heyn, D. Heller. 1980. Conspectus Florae Orientalis. Fascicle 1. The Israel academy of sciences and humanities, 107 pp.
- Zwölfer, H. 1969. Experimental feeding ranges of species of Chrysomelidae (Coleoptera) associated with Cyanareae (Compositae) in Europe. *Technical Bulletin of the Commonwealth Institute of Biological Control*, No. 12, pp. 115-130.