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LARVAL MORPHOLOGY AND BIOLOGY OF A NORTH AMERICAN AND AN ISRAELI *ALTICA* SPECIES (COLEOPTERA: CHRYSOMELIDAE: ALTICINAE)

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ABSTRACT

The mature larvae of *Altica bicarinata* (Kutschera) and *A. marevagans* Horn, collected in Israel and North America, respectively, are described and illustrated in detail for the first time. Some remarks on their taxonomy and biology are also given along with some discussion of the state of knowledge of alticine larvae.

Key Words: *Altica,* larvae, Florida, Israel, *Rubus*, *Oenothera*

RESUMEN

Las larvas maduras de *Altica bicarinata* (Kutschera) y *A. marevagans* Horn, colectadas en Norte América e Israel, estan descritas e ilustradas en detalle por primera vez. Algunos comentarios sobre su taxonomía y biología están incluidos, así como también una discusión sobre el estado de conocimiento de las larvas de Alticinae.

Alticinae larvae, including forest and agricultural pests, were studied by many workers from morphological and biological perspectives. Ogloblin & Medvedev (1971), Kimoto & Takizawa (1994), and Steinhausen (1994) studied many genera of alticine larvae taxonomically using the chaetotaxy of the anal plate. Some workers conducted a variety of studies: Rupertsberger (1894); Sanderson (1902); Henriksen (1927); Reed (1927); Böving & Craighead (1931); Grandi (1932, 1938); Newton (1933); Anderson (1938); Paterson (1931, 1943); Dobson (1960); Yano (1963, 1965); Giljarov & Medvedev (1964); Steinhausen (1966, 1978, 1994); Welch (1972); Westdal & Romanov (1972); Zaitev & Medvedev (1977); Medvedev & Zaitev (1978); Vig (1989); Lawson (1991); Lee (1992); Medvedev (1992); Doguet (1994); Lee et al. (1998); but the majority of the studies have been done recently (i.e., since 1970). For a review of most of these see Steinhausen (1996). The present authors describe and illustrate the mature larvae belonging to two Alticinae species collected in North America and Israel; *A. marevagans* (Horn) and *Altica bicarinata* (Kutschera), respectively.

Since studies of chrysomelid larvae conducted by Henriksen (1927), Böving (1927, 1929), and Böving and Craighead (1931) have indicated that there are very few detectable differences between larvae of Galerucinae and Alticinae (see also Marshall 1980 and Lawrence & Britton 1991, but see Lawson 1991 showing differences), these two largest chrysomelid subfamilies often have been treated together when discussing the larvae. Böving (1927), apparently following the classification scheme of Leng (1920), suggested that if the Diabroticini and Phyllobroticini (whose larvae were eas-

ily separated from the rest of the Galerucinae) were removed from the subfamily Galerucinae and placed with the Systenini, Crepidoderini, and Psylliodini of the subfamily Halticinae, then it would be possible to separate the rest of the larvae into the traditional two subfamilies of Galerucinae and Alticinae as with the adults. Later, in order to solve this problem, Böving and Craighead (1931) used a classification with the family Galerucidae containing three subfamilies: Galerucinae; Diabroticinae (containing *Phyllobrotica* Chevrolat); and Halticinae. These larval studies by Böving were done with the material available at the U.S. National Museum, which at that time contained 6 of the 12 Galerucinae tribes. The studies of the Alticinae larvae were apparently done using only 14 genera, primarily of species from the U.S.A. but with a few from Denmark.

Böving (1927) said that the Halticini [containing *Altica* Geoffroy] were well known because of the various publications by W. C. Woods and considered typical of all other Halticinae. However, Böving (1927) said that "in general aspect and structural details the Halticini larvae are more similar to the main bulk of the Galerucinae larvae than these latter [Galerucinae] are to the Diabroticini and Phyllobroticini larvae and more than the Halticini larvae themselves are to the Halticinae tribes Systenini, Crepidoderini, and Psylliodini." Unlike most other Alticinae (root feeders), *Altica* [Halticini-*sensu* Leng (1920) and Böving (1927)] are external leaf feeders and are generally quite easy to rear. Therefore, it is interesting that it is only recently that most of the western Palearctic species of *Altica* larvae have been described (Bartkowska & Warchalowski 1978, Steinhausen 1994, 1996). The percentage of described larvae in North American is much smaller. In the western Palearctic Region, only 19% of the Alticinae larvae are known (Steinhausen, 1996), and many of these are either external leaf feeders, leaf miners (e.g., *Argopus* Fisher, *Dibolia* Latreille, *Mantura* Stephens, *Sphaeroderma* Stephens, etc.—relatively easy to rear) or species of significant agricultural importance (e.g., *Phyllotreta* Chevrolat, *Psylliodes* Latreille, etc.).

Materials and Methods

All specimens used in this study were collected by the second author and preserved in 70% ethyl alcohol. The final instar larvae were macerated in KOH solution for 30 minutes, rinsed in water, and dissected under an Olympus stereoscopic microscope. For morphological studies of the minute structures, the parts were mounted on slides and observed through the compound microscope (Leitz). The terminology of setae in this study is adopted from Anderson (1947). Biological observations were made by the second author in the field or in captivity during rearing activities. Voucher specimens of the larvae of both species have been deposited in the National Museum of Natural History, Washington, D.C.

Historical Review of Larval Taxonomic Studies of the Genus *Altica*

Five North American species of *Altica* larvae (*A. bimarginata* Say, *A. corni* Woods, *A. rosae* Woods, *A. torquata* LeConte and *A. ulmi* Woods) were studied by Woods (1917, 1918). Urban (1928) only superficially described *H. lythri* Aubé and *H. brevicollis* Foudras, without any illustrations. *Altica bimarginata* was briefly illustrated by Böving & Craighead (1931). Paterson (1931) briefly described and illustrated *Haltica lythri*. *Haltica cuprea* Jacoby was also described by Paterson (1943). *Altica chalybea* Illiger was briefly described and illustrated by Peterson (1960). *Altica chalybea* and *A. corni* were illustrated by Lawson (1991). Oglobin & Medvedev (1971) made a key to two Palearctic species: *Haltica oleracea* (Linnaeus) and *H. tamaricis* Schrank). Bart-

kowscka & Warchalowski (1978) made a taxonomic key to 9 European species. Medvedev & Zaitzev (1978) illustrated only 1 species (*Altica oleracea*), using dorsal tubercles of the abdominal segments. Phillips (1977) discussed color changes, phenology, and morphology of spined tubercles of *A. lythri*. Phillips (1979) only very briefly described the color of *A. ericeti* (Allard), *A. lythri*, *A. oleracea*, and *A. palustris* Weise. Two Japanese species, *Altica caerulescens* (Baly) and *A. cirsicola* Ohno, were fully described and illustrated by Lee (1992). Only the dorsal part of the tubercles of 9 European species were illustrated by Steinhausen (1994). Kimoto & Takizawa (1994, 1997) illustrated and provided keys for 12 eastern Palearctic species. Most significant larval studies of species of *Altica* were done only recently (1978 and since).

Larval Descriptions and Notes

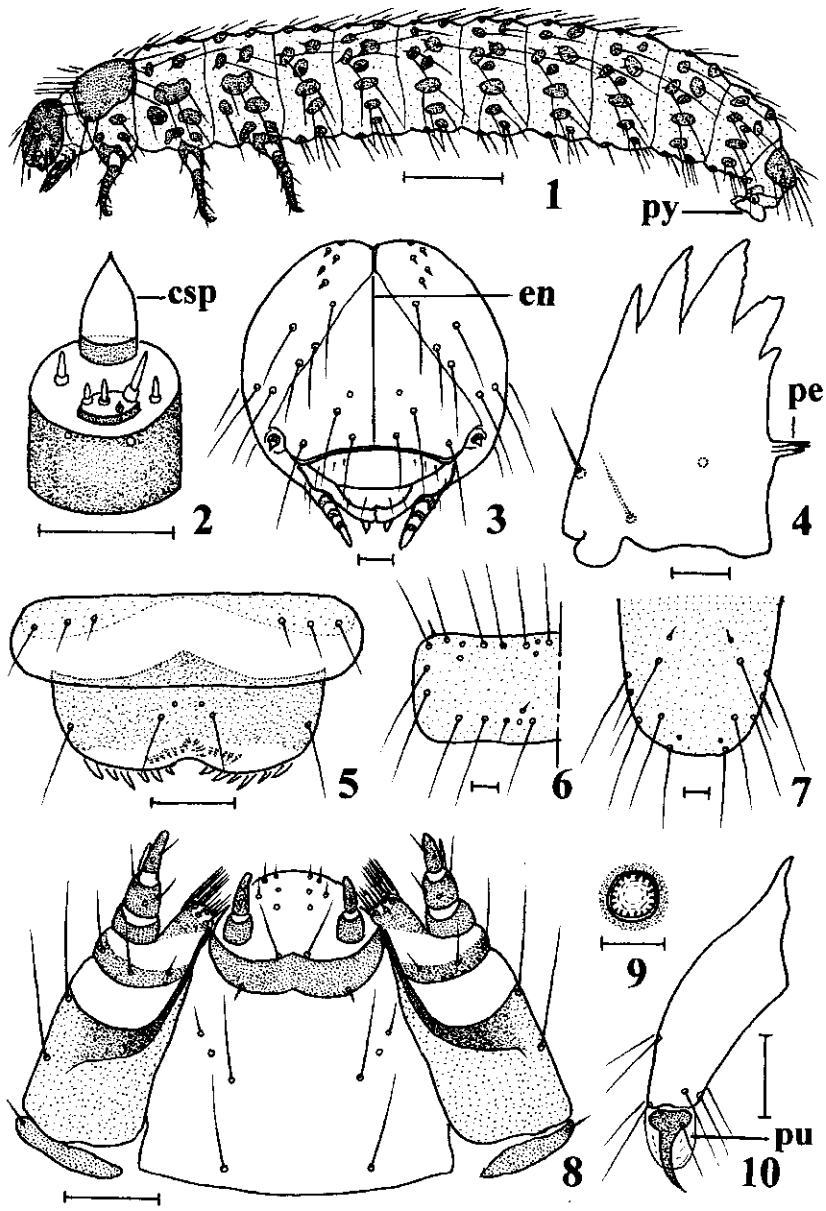
Altica bicarinata (Kutschera)
(Figs. 1-10)

Mature larva (Fig. 1). Body blackish brown, nearly straight, elongate, micro-sculptured and densely covered with setae; head and mandibles dark brown, pronotum, tubercles, spiracles and legs pale brown; head (Fig. 3) hypognathous, rounded, slightly sclerotized; frontal suture narrowly divergent and straight; hind corner of epicranium slightly produced; coronal suture short; epicranium with 10 pairs of dorsal setae (4 pairs are minute), 2 pairs of lateral setae and 1 pair of dorsal sensilla; frons with 3 pairs of frontal setae and 1 pair of frontal sensilla; endocarina distinct for full length; epistomal suture developed; stemmata absent; antenna (Fig. 2) 2-segmented, segment 1 with a large conical sensory papilla, 2 setae and 2 sensilla, segment 2 with 4 setae; clypeus with 3 pairs of clypeal setae; labrum slightly incised in the middle of anterior margin, with 2 pairs of labral setae and 1 pair of labral sensilla; epipharynx with 6 pairs of epipharyngeal setae; hypopharynx with many hypopharyngeal spinules; mandible (Fig. 4) palmate, well sclerotized, with 5 distal teeth, 2 mandibular setae, 1 sensillum and 3 sharp penicilli; maxillary palp (Fig. 8) 3-segmented, segment 1 without seta, segment 2 with 2 setae and 1 sensillum, segment 3 with 2 setae and 1 sensillum; palpifer with 3 setae; stipes with 2 setae; cardo with 1 seta; galea with 8 setae; lacinia with tightly bunched group of 8 setae located behind galea; labial palp 2-segmented; prementum and postmentum separated by sclerotized membrane; prementum with 4 pairs of setae and 1 pair of sensilla, postmentum with 4 pairs of setae and 1 pair of sensilla; pronotum (Fig. 6) brown, well sclerotized, with 14 pairs of setae and 5 pairs of sensilla; mesothoracic spiracles (Fig. 9) annuliform, situated on epipleural anterior part, with peritreme strongly sclerotized; epipleuron with 3 setae; legs (Fig. 10) rather long and slender; tibia with 7 setae; tarsungulus falciform, slightly curved anteriorly, enlarged base with 1 seta; pulvillus whitish, bladder-like; typical abdominal segments with two folds; epipleuron with 2 setae; abdomen with 8 pairs of spiracles; anal plate (Fig. 7) with 7 pairs of setae and 1 pair of sensilla; pygopod (Fig. 1) well developed.

Body length: 7.8 mm (number examined: n = 5). Head width: 0.9 mm (n = 5).

Materials examined. Israel: Golan Heights, Qusbiye, 28 April 1974, larvae collected on the leaves of the perennial edible raspberry *Rubus sanctus* Schreb. (= *R. sanguineus* Frivaldszk), and determined by association with adults by D. Furth.

Remarks. The larva of this species closely resembles that of *Altica lythri* treated by Paterson (1931), but differs by having the mandible with a well-developed penicillum. The cephalic setae are arranged similarly to those of other alticine larvae, but in this species there are 10 pairs (4 pairs are minute) of setae on the vertex. Voucher specimens will be deposited in the National Museum of Natural History, Washington, D.C.



Figs. 1-10. *Altica bicarinata*: (1) mature larva, lateral view; (2) antenna, dorso-lateral view; (3) head, anterior view; (4) mandible, buccal view; (5) clypeus, labrum and epipharynx, frontal view; (6) pronotum, dorsal view; (7) anal plate, dorsal view; (8) lower mouth parts, ventral view; (9) spiracle, lateral view; (10) left hind leg, lateral view. Scale line—1.0 mm (Fig. 1); 0.5 mm (Figs. 3, 7, 8); 0.1 mm (Figs. 2, 4, 5, 6, 9, 10).

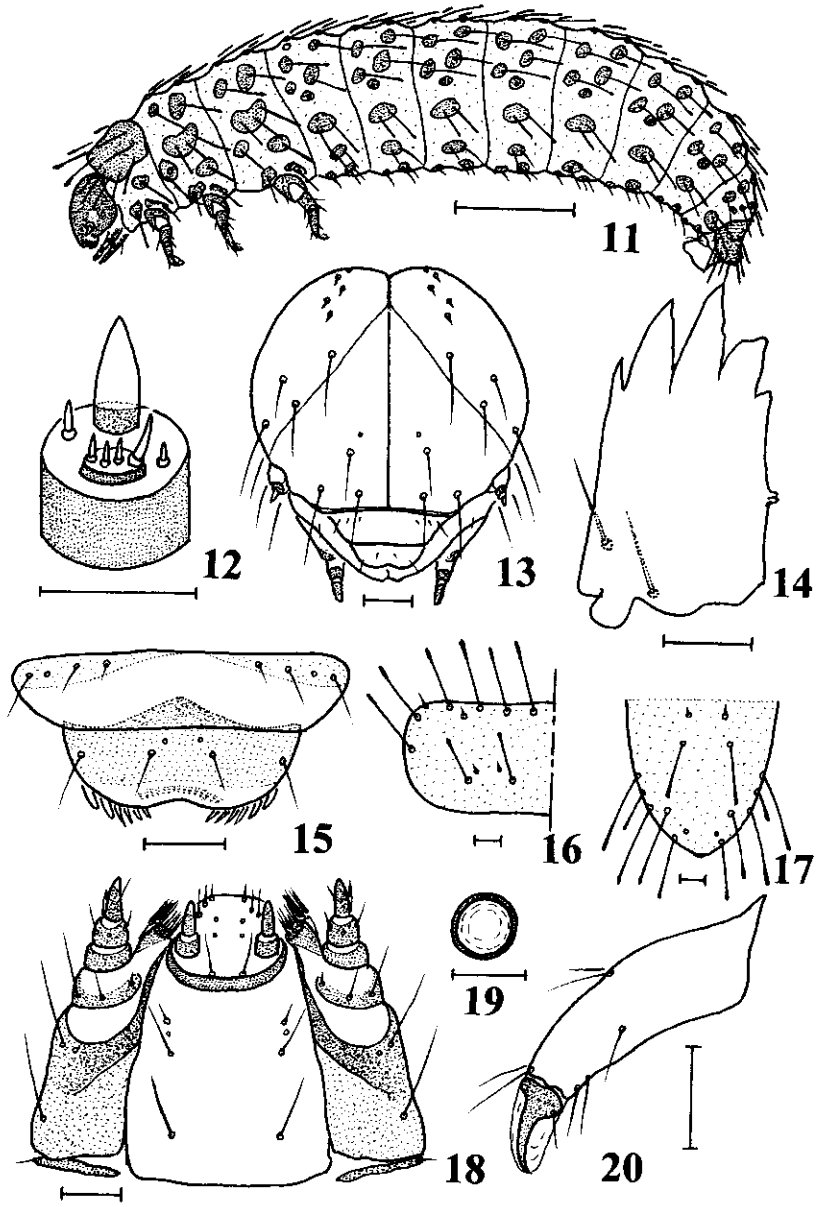
Biological Notes. Adults were collected during all months of the year in Israel (Furth 1981). The second author has examined adult specimens from the Nile River area in Egypt; however, otherwise, *A. bicarinata* is not known from west of central Israel. This species is the most common *Altica* in the eastern Mediterranean area and is monophagous feeding exclusively on *Rubus sanctus*. The food plant species is found around the Mediterranean as well as in Iran and Iraq occurring on the banks of or near rivers, streams, springs, swamps, etc. It has crossed with many other species of *Rubus* (Zohary et al. 1980). In modern times, this plant is extremely rare and relictual (high mountains) in the southern desert areas of Israel and Egypt (Negev and Sinai); however, presumably in the more moist times of the late Pleistocene it was more common and widespread across these areas (for further details see Furth 1981). Interestingly, at the Greek Orthodox monastery (Santa Katarina) on Mt. Sinai (Egypt), *R. sanctus* is the plant indicated as the supposed "burning bush" from the biblical story of Moses receiving the Ten Commandments on Mt. Sinai.

Larvae were collected by the second author in Israel from 6 March through 31 May and in Cyprus on 31 August. Eggs eclose in 7-12 days, and larvae feed (skeleonize) on both leaf surfaces. Larvae feed for about 30 days, then pupate in the soil beneath their host. Adults eclose in about 7 days (i.e., complete life cycle [egg to adult] is approximately 40-50 days). There are two to three generations per year in Israel. Food plant preference testing indicated that *A. bicarinata* is monophagous on *R. sanctus* (Furth 1981). Adults and larvae could often be found together in large numbers, especially in March and April, and to a lesser extent May. Large localized areas of the food plants were often completely defoliated and appeared "burned", but actually the leaves were skeletonized and dried out or desiccated.

Another interesting phenomenon concerning *A. bicarinata* concerns its predator *Zicrona coerulea* (Linnaeus) (Hemiptera: Pentatomidae), which is widespread throughout the Palearctic Region. The nymphs and adults of this true bug are well-known to attack the larvae of a variety of species of *Altica* as well as some other prey. The adult bug is exactly the same metallic blue/green color as the adults of *Altica*. This phenomenon may have evolved as some sort of Batesian mimicry (see Furth 1981 and Furth 1983 for a detailed discussion).

Altica marevagans Horn
(Figs. 11-20)

Mature larva (Fig. 11). Body blackish brown, slightly curved, micro-sculptured and with dorsal parts of body, except head covered with club-shaped setae; head and mandibles dark brown, pronotum, tubercles, spiracles and legs brown; head (Fig. 13) hypognathous, rounded, slightly sclerotized; frontal suture somewhat divergent and straight; hind corner of epicranium slightly produced; coronal suture short; epicranium with 8 pairs of dorsal setae (4 pairs of them minute), 3 pairs of lateral setae and 1 pair of dorsal sensilla; frons with 3 pairs of frontal setae and 1 pair of frontal sensilla; endocarina distinct for full length; epistomal suture developed; stemmata absent; antenna (Fig. 12) 2-segmented, segment 1 with a large conical sensory papilla, 2 setae, segment 2 with 4 setae; clypeus (Fig. 15) with 3 pairs of clypeal setae and 1 pair of clypeal sensilla; labrum slightly incised in the middle of anterior margin, with 2 pairs of labral setae and 1 pair of labral sensilla; epipharynx with 6 pairs of epipharyngeal setae; hypopharynx with many hypopharyngeal spinules; mandible (Fig. 14) palmate, well sclerotized, with 5 distal teeth, 2 mandibular setae and 2 short penicilli; maxillary palp (Fig. 18) 3-segmented, segment 1 without seta, segment 2 with 2 setae and 1 sensillum, segment 3 with 2 setae and 1 sensillum; palpifer with 3 setae; stipes



Figs. 11-20. *Altica marevagans*: (11) mature larva, lateral view; (12) antenna, dorso-lateral view; (13) head, anterior view; (14) mandible, buccal view; (15) clypeus, labrum and epipharynx, frontal view; (16) pronotum, dorsal view; (17) anal plate, dorsal view; (18) lower mouth parts, ventral view; (19) spiracle, lateral view; (20) left hind leg, lateral view. Scale line—1.0 mm (Fig. 11); 0.5 mm (Figs. 13, 17, 18); 0.1 mm (Figs. 12, 14, 15, 16, 19, 20).

with 2 setae and 1 sensillum; cardo with 1 seta; galea with 8 setae; lacinia with tightly bunched group of 8 setae located behind galea; labial palp 2-segmented; prementum and postmentum separated by sclerotized membrane; prementum with 4 pairs of setae and 2 pairs of sensilla, postmentum with 3 pairs of setae and 1 pair of sensilla; pronotum (Fig. 16) brown, well sclerotized, with 12 pairs of setae (8 pairs long and club-shaped); mesothoracic spiracles (Fig. 19) annuliform, situated on epipleural anterior part, peritreme well sclerotized; epipleuron with 3 setae; legs (Fig. 20) rather long and slender; tibia with 7 setae; tarsungulus falciform, slightly curved anteriorly, enlarged base with 1 seta; pulvillus whitish, bladder-like; typical abdominal segments with two folds; epipleuron with 2 setae; abdomen with 8 pairs of spiracles; anal plate (Fig. 17) with 7 pairs (6 pairs long and club-shaped) of setae and 1 pair of sensilla; pygopod well developed.

Body length: 6.5 mm (n = 5). Head width: 0.7 mm (n = 5).

Materials examined. U.S.A.: Florida, Lido Beach, 16 April1975, larvae collected on the leaves of *Oenothera humifusa* Nutt. and determined by association with adults by D. Furth.

Remarks. The larva of this species closely resembles that of *Altica cirsicola* as described by Lee (1992), but is different in the following characters: mandibles with penicillus, frons with 3 pairs of setae and prementum with 4 pairs of setae.

Biological Notes. Larvae were collected on the following dates in the Sarasota, Florida area: 16 April 1975; 9 May 1981. Adults were collected on dates given in Flowers et al. (1994). Larvae were found co-occurring with adults in April and May. The primary food plant (*Oenothera humifusa*) has succulent leaves, is low-growing and is commonly found along beaches even in areas disturbed by active public recreation.

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