1972

Biologies of Altica subplicata (LeConte) and Disonycha alternata (Illiger) (Coleoptera: Chrysomelidae) found on Salix interior Rowlee

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BIOLOGIES OF ALTICA SUPPLICATA (LECONTE)
AND DISONYCHA ALTERNATA (ILLIGER) (COLEOPTERA: CHRYSOMELIDAE)
FOUND ON SALIX INTERIOR ROWLEE

BY

DAVID H. DESWART

A thesis submitted in partial fulfillment of the requirements for the degree Master of Science, Major in Entomology, South Dakota State University

1972
BIOLOGIES OF ALTICA SUPPLICATA (LECONTE)
AND DISONYCHA ALTERNATA (ILLIGER) (COLEOPTERA: CHRYSOMELIDAE)
FOUND ON SALIX INTERIOR ROWLEE

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Adviser/ Date

Head, Entomology-Zoology Department Date
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INTRODUCTION

_Disonycha alternata_ (Illiger) and _Altica subplicata_ (LeConte) are two flea-beetles characteristically found feeding on _Salix_ spp. The only studies done to date on these two genera are taxonomic, either local faunistic or descriptive works. Both _Disonycha_ and _Altica_ have been taxonomically studied for limited zoogeographic areas, but many of these works are old, incomplete, and in need of revision. No previous work has been done on the biologies of either of these two species.

This paper includes morphological descriptions of the larvae of _D. alternata_ and _A. subplicata_ and outlines their life histories. A few notes on behavior have also been included in the life history section. This research augments the scant knowledge now available on the biologies of these genera and helps to clarify their taxonomy by establishing distinctive ecological patterns.

_Altica subplicata_ (LeC.) and _Altica plicipennis_ (Mann.) are both members of the _A. bimarginata_ species-complex which feed on _Salix_ spp. These 2 species have been confused in the past and there is still some question as to whether or not they are distinct species. Likewise, _Disonycha alternata_ (Ill.) and _Disonycha pluriligata_ (LeC.) are both members of the _D. alternata_ species-complex which also feed on willow. Some individuals still question whether or not these are 2 distinct species. This paper was intended to help clarify the confusion by providing ecological information on 2 of the 4 species in question.
LITERATURE REVIEW

Altica subplicata (LeConte)

Altica subplicata LeConte, 1859, 25.
Altica bimarginata Horn, 1889, 219-220.

Taxonomy - The genus Altica Fabricus (Coleoptera: Chrysomelidae) was described in 1775. Geoffroy first used the name Altica in 1762, but invalidly as a nomen nudum (Wood, 1917; Gressitt & Kimoto, 1963; Stoll, 1964). Confusion also has occurred in the proper spelling of the generic name. Haltica, which contains the aspirate 'H', was used by Illiger in 1802 and by Hoffman in 1803 (Wood, 1917). Such emendation, however, is not permitted by the International Code of Zoological Nomenclature (Stoll, 1964).

Altica subplicata was described by LeConte in 1859 (Blake, 1936). Although Horn (1889) did not include this species in his study of the Alticini, A. subplicata keys to Altica bimarginata Say in his work. Blake (1936), in a revision of the A. bimarginata species-complex, again recognized A. subplicata as a distinct species.

Morphology - Very few in depth studies on the morphology of species of Chrysomelidae can be found. Many of the chrysomelids, however, have been worked in a superficial manner. Some papers with reference to Altica spp. are available, but none pertaining specifically to A. subplicata. Packard (1887) wrote a brief description of Haltica alni Harris which is now considered to be a subspecies of Altica ambiens (LeConte). Wood (1917) described the larvae and pupae of what was then considered to be A. bimarginata. He also included
Horn's (1880) description of the adult. *Altica bimarginata*, however, has since been recognized to encompass more than one species (Blake, 1936), and the beetle that Wood referred to was most likely *Altica ambiens alni* (Harris). The following year, Wood (1918) described the egg, larvae, pupae and adults of *Altica torquata* LeC. and three members of the *Altica ignita* complex, viz. *Altica corni* Wood, *Altica rosae* Wood, *Altica ulmi* Wood. Dirks-Edmunds (1965) described the stages of *Altica tombacina* (Mann.) from egg through adult.

**Life History** - Packard (1887) wrote a brief life history of *A. ambiens alni* (Harris) [= *Haltica alni* Harris]. Wood (1917) did the biology of *Altica ambiens alni* (Harris) [= *A. bimarginata* Say]. He later followed this study with a report on the biology of the Maine species of *Altica* which included the life histories of *A. corni* Wood, *A. rosae* Wood, *A. ulmi* Wood and *A. torquata* LeC. (Wood, 1918). Shaw, Bailey and Wheeler (1950) published notes on the life history and control of *Altica sylvia* Malloch on blue berries in Massachusetts. Harris (1964) included a brief life history of *Altica carduorum* Guer. in his paper on host specificity of that species. Dirks-Edmunds (1965) did a very complete study of the life history of *A. tombacina* (Mann.) as it occurs on fireweed (*Epilobium angustifolium* L.) in Oregon.

**Disonycha alternata** (Illiger)

*Haltica alternata* Illiger, 1807, 144.


**Disonycha alternata**, Strum, 1843, 64.
Disonycha quinquevittata Horn, 1889, 203.

Disonycha quinquevittata punctigera Schaeffer, 1931, 279.

**Taxonomy** - Very few papers, other than taxonomic, have been published on Disonycha alternata (Illiger) (Coleoptera: Chrysomelidae) which was described by Illiger in the genus Haltica in 1807 (Blake, 1933). In the early 19th century, Altica encompassed the Disonycha spp., as well as many other flea beetle groups (Wood, 1917).

The name Disonycha was first used by Chevrolat in the Dejean catalogue in 1837. However, for a long time after Dejean's publication, many species more properly assigned to Disonycha were included in the genus Altica (Blake, 1933).

Disonycha alternata was first included in a key to the United States species of Disonycha by Crotch (1873). Horn (1889) failed to include D. alternata in his study of the Alticini, which keys to Disonycha quinquevittata Say in his work. Schaeffer (1931), who questioned the validity of the varieties of D. quinquevittata, listed D. alternata under D. quinquevittata. Blake (1933) recorded D. alternata as a distinct species, separating it from the D. quinquevittata species-complex.

**Morphology** - Blake (1933) wrote a taxonomic description of adults of D. alternata and hers is the only published paper on their morphology. Chittenden (1899) described the eggs, larvae, pupae, and adults of Disonycha xanthomelas Dalman. He later, (Chittenden, 1912), briefly described the yellow-necked flea beetle, Disonycha collata (Fabricius) [=Disonycha mellicollis Say], and listed its known distributions. Blake (1933), with whom I concur, listed D. mellicollis
as a doubtful species and synonymized it with *D. collata* (Fab.) and *D. semicarbonata* LeC. Danforth (1924) briefly described the eggs, larvae, pupae and adults of *Disomycha laevigata* Jacoby in Porto Rico. Garman (1889) described the eggs, mature larvae, pupae and adults of *Disomycha glabrata* Fabricius and, in 1891, reworked the same material for a second publication (Garman, 1891). Hemenway and Whitcomb (1968) also briefly described the life stages of *D. glabrata*.

**Life History** - No previous work has been done on the life history of *D. alternata* although the following are other *Disomycha* spp. for which something of the biology is known. Chittenden (1899) described briefly the life history and stages of *D. xanthomelas*. He later (Chittenden, 1912) published a paper on *D. collata* [= *D. mellicollis* Say] in which he included a report by H. O. Marsh on the life history of this beetle. Danforth (1924) wrote briefly on the life history of *D. laevigata* Jacoby in Porto Rico. A number of papers have been published on *D. glabrata*, which feeds on *Amaranthus retroflexus* (pigweed), since it was hoped that *D. glabrata* might prove useful as a biological control of this weed. Garman (1889) made brief mention of the habits of this beetle in Kentucky, and republished approximately the same information with minor changes in 1891 (Garman, 1891). Hemenway and Whitcomb (1968), however, wrote a complete life history of *D. glabrata*. They reared the beetles in the laboratory and made field observations to supplement their laboratory findings.
Methods and Materials

*Altica subplicata*

The study on *Altica subplicata* was conducted in two sections. The first consisted of laboratory rearing of the beetles and the second of field observations made to supplement the laboratory work.

**Laboratory** - Laboratory rearing was carried out in late spring and summer of 1970. Specimens of *A. subplicata* were collected on *Salix interior* Rowlee along the Missouri river near Elk Point, South Dakota. From this original stock of beetles, a laboratory colony was established. *Altica subplicata* was easily reared in the laboratory, requiring only prevention from desiccation and a proper fresh food source.

Fresh cuttings of *Salix interior* were gathered every other day and used as a food source. At the beginning of this study, one of the major problems encountered was to find a way of keeping the cut willow shoots in an edible condition. Willow leaves, in a hot dry climate, become tough and hard a short time after they are cut, making them unpalatable to the beetles. It was discovered that the best way to insure the relative freshness of the willow was to immediately submerge the cuttings in water and place them in a refrigerator. Willow cuttings thus obtained were easily kept for at least three days. It was also important to keep the humidity level in the rearing containers fairly high. This maintained palatability of the willow for at least 24 hours.

Three types of rearing containers were used. The first, type I (Fig. 1), from which most of the data was obtained, consisted of a
Fig. 1. - Type I rearing container.
½ gallon plastic ice cream container with a hole cut into the removable top. The hole was then covered with a piece of saran wrap which had numerous punctures to facilitate air transfer and to prevent condensation build-up. Holes were also cut into the bottom of the container to allow for adequate drainage.

In preparing the container to receive the beetles, 2 cm of sand were placed on the bottom and moistened with 10 ml of water. Additional water was added whenever the sand started to appear dry. Willow shoots were then placed into the container with their cut ends entering the wet sand.

Seven-12 pairs of adult *Altica subplicata* were placed in each container and allowed to lay eggs for 3-4 days before moving them to a new one. At this time all plant material was removed from the old container. Most of the egg masses were attached to the willow leaves. These egg masses were cut from the old plants and placed into the original container to hatch. After the eggs hatched, fresh willow was again added to the container every day. It was possible to add cuttings to the containers for 5-7 days before they needed cleaning. The larvae would transfer from the old willow to the new by themselves. This helped a great deal in removing the old plant wastes. After the larvae pupated, the willow shoots were again completely removed from the containers and placed into new ones. The type I containers appeared to work best for rearing moderately large numbers of insects conveniently.

The second type of container, type II (Fig. 2), consisted of a large baby food jar with the center of its lid cut out. The top of
Fig. 2. - Type II rearing container.
the jar was then covered with a paper napkin and the metal rim was screwed down over this. At the start of the study, the jars were used with their original solid lids. This, however, caused large temperature fluctuations through lack of proper ventilation, and also allowed excess humidity and condensation build-up.

Prior to receiving the beetles, each jar was prepared by placing 45 gm of sand into the bottom. This sand was then moistened with 5 ml of water. Three-4 fresh willow shoots, with 2-6 leaves per shoot, were placed into each jar. During the study period, the old shoots were removed and fresh willow was added daily. Five ml of water was added every other day, or as needed, to provide adequate humidity.

The type II container was used for egg studies and pair observations. One pair of copulating beetles was placed into each jar. Egg counts were made for individual pairs of beetles. The plants were changed and an egg count was taken daily.

The third type of container, type III (Fig. 3), was used for instar determination experiments. Each container consisted of a 5 dram pill vial with a plastic screw-on cap. Here again the center of the top was cut out and replaced with a piece of napkin. Each container was set up with a small piece of sponge on the bottom which was moistened with 1 ml of water. New tender leaves from the terminal shoots of the willow were used in the instar tests. Two fresh leaves were placed in each vial every day and a small amount of water was added to keep up the humidity. Two newly hatched larvae were placed into each vial and observed daily to record changes. Throughout the study, representative samples were taken of eggs, larvae, pupae, and
Fig. 3. - Type III rearing container.
adults. These were preserved in 70% alcohol for later study.

The rearing experiments were conducted in an insectary adjacent to the author's home within the city of Brookings. The building was well ventilated and inside temperatures corresponded closely with those outside. Rearing containers were exposed to direct sunlight throughout the morning hours and to indirect sunlight throughout the afternoon. It was attempted, as nearly as possible, to simulate the conditions found in the natural environment. Temperatures were taken both inside and outside of the different types of rearing containers and compared. It was found that during daylight hours the temperature inside the containers was usually slightly higher than that found outside, and that at night, both temperatures were nearly the same. In the type I container the temperature fluctuated from equal to 1–2 degrees higher than outside. In the type II container the temperature was found to vary from equal to 2–4 degrees higher than that found outside. The temperature variations occurring during the rearing season are shown in Fig. 38. This figure shows representative temperatures taken inside of the rearing containers.

Field Work – Field work was done to supplement laboratory findings. Willow species were sampled in various areas throughout Brookings County to determine natural habitat and host preference of A. subplicata.

The study was begun in early June of 1969, with a preliminary sampling of possible study sites in the immediate Brookings area. Special emphasis was placed on locating small groves of willow with approximately the same species composition. In May 1970, a similar
survey was conducted throughout Brookings County. The combined results of both years yielded several acceptable study sites. At each of these sites, representative trees were labeled using a felt-tipped pen and cardboard tags. Samples of leaves and branches were taken from the tagged trees and pressed for later identification. When possible, catkins were collected and preserved in 70% alcohol.

From mid-May through mid-September 1970, periodic visitations were made to these sites and notes were taken. Intensive collecting of insects was also conducted at this time. Collecting was done by hand picking and by sweeping the branches with a net. The insects were then collected from the sweepings with an aspirator and immobilized with ethyl ether. These specimens were taken to the laboratory and preserved in 70% alcohol for later identification. Supplemental collecting was also done during the spring of 1971 to augment the previous year's findings.

The three types of collection sites used can be categorized as primary, secondary, and incidental sites. Six primary sites were visited at least twice a week. Seven secondary sites were visited at least twice a month. Incidental sites were collecting areas where random stops were made or where stops were made less than twice a month, and except for site A-100, are not listed in this paper. The following are descriptions of the various primary and secondary sites.

Site, C-100. Primary collection site, 1970-71. The site is located along an all-season tributary of the Big Sioux River on the south side of Brookings Co. Highway 18, 3 km west of U.S. Highway 77. The area is a strip of vegetation along a creek and is approximately
6 m by 21 m. The only willow species found was *Salix amygdaloides* Andress. Total vegetation was composed of 80% *S. amygdaloides* and 20% other species. The substrate for the area was sandy soil.

Site, C-101. Primary collection site, 1970. The site is located on the north side of Brookings Co. Highway 18, 5 km west of U.S. Highway 77. It is an upland farm shelter belt, approximately 4.5 m by 30.5 m. The willow species found there include *S. amygdaloides* and *Salix pentandra* L. Total vegetation was composed of 70% *S. amygdaloides* and 30% *S. pentandra*. The substrate for the area was loam soil.

Site, C-105. Primary collection site, 1970-71. The site is located on the north side of Brookings Co. Highway 18, 15.5 km west of U.S. Highway 77. The area is roughly circular, approximately 45 m in diameter and located in a low pasture area. The only willow species found was *Salix interior* Rowlee. Total vegetation was composed of 90% *S. interior* and 10% other species. The substrate for the area was black muck soil.

Site, C-109. Primary collection site, 1970-71. The site is located on the south side of the bend in U.S. Highway 77, 5 km south of Brookings. The area is long and narrow, measuring \( \frac{1}{2} \) km long by 6 m to 15 m wide. It is found in a low area of the pasture alongside the road. Willow species found there include *S. interior* and *Salix lutea* Nutt. Total vegetation was composed of 90% *S. interior*, 5% *S. lutea* and 5% other species. The substrate for the area was loam soil.

Site, D-100. Primary collection site, 1970-71. The site is
located on the east side of U.S. Highway 77, adjacent to the Big Sioux River and 11 km south of Brookings. The area is roughly oblong-oval, approximately 4.5 m by 12 m and along the river bank. The only willow species found was S. interior. Total vegetation was composed of 100% S. interior. The substrate for the area was gravel.

Site, D-101. Primary collection site, 1970-71. The site is located at the northeast corner of U.S. Highway 77 and the Moody Co. line and 12 km south of Brookings. The area is roughly rectangular, approximately 18 m by 30.5 m and is an old ox-bow of the Big Sioux River. The willow species found there include S. amygdaloid es and S. interior. Total vegetation was composed of 40% S. amygdaloid es, 30% S. interior, and 30% other species. The substrate for the area was sandy soil with 1 large gravel bar.

Site, B-100. Secondary collection site, 1970. The site is located east of U.S. Highway 77 at the Brookings Municipal Golf Course, 1 km north of the junction of U.S. Highway 77 and U.S. Highway 14 bypass. The area is roughly circular, approximately 9 m in diameter with a seasonal creek running through it. Willow species found there include S. interior and S. amygdaloid es. Total vegetation was composed of 60% S. interior, 10% S. amygdaloid es and 30% other species. The substrate for the area was sandy clay mixed with gravel. This area was used mainly as a food source for the laboratory insects.

Site, C-106. Secondary collection site, 1970. The site is located near a bridge, 6 km west of Volga and 4 km south of U.S. Highway 14. The area consists of two trees along a seasonal creek. The only willow species found was S. amygdaloid es. Total vegetation was
100% S. amygdaloides. The substrate for the area was clay soil.

Site, C-108. Secondary collection site, 1970-71. The site is located at the spillway on the north end of Lake Campbell, 8 km south of Brookings and 4 km west of U.S. Highway 77. The area is extensive, covering ½ section. Vegetation is variable but predominantly Salix spp. Willow species found there include S. interior, S. amygdaloides, and Salix eriocephala Michx. The substrate for the area was of mixed types ranging from sand to black muck soil.

Site, C-110. Secondary collection site, 1970-71. The site is located on the west side of U.S. Highway 77, 8 km south of Brookings. The area is long and narrow, measuring approximately 122 m by 9 m. It is situated along an old, dry stream bed. The only willow species found was S. interior. Total vegetation was composed of 100% S. interior. The substrate for the area was sandy clay soil.

Site, C-111. Secondary collection site, 1970-71. The site is located at the Kellogg Gravel Pit on the west side of U.S. Highway 77, 11 km south of Brookings. The area is composed of short strips of vegetation along the edges of water filled gravel pits. Willow species found there include S. interior and S. amygdaloides. Total vegetation was composed of 90% S. interior, 2% S. amygdaloides and 8% other species. The substrate for the area was gravel (Fig. 36).

Site, C-112. Secondary collection site, 1969. The site is located on the east side of Brookings Co. Highway 19, 11 km south of U.S. Highway 14. The area is roughly rectangular, approximately 30.5 m by 6 m and on very low ground. The only willow species found was S. interior. Total vegetation was composed of 75% S. interior and
25% other. The substrate for the area was clay soil. This area was under water throughout the spring and most of the summer in 1970.

Site A-100 was visited only 5 times in 1970 and 4 times in 1971 and is therefore an incidental area. However, it was felt that it should be included here as it yielded a good deal of pertinent information. This area is located on the southeast corner of the intersection of Brookings Co. Highway 7 and Brookings Co. Highway 40. It is adjacent to the Big Sioux River, 5 km south of Estelline. The area is roughly rectangular, approximately 6 m by 15 m and located along the river bank. Willow species present in the area include *S. interior* and *S. eriocephala*. Total vegetation was composed of 50% *S. interior*, 10% *S. eriocephala* and 30% other species. The substrate was a gravel bank, covering approximately 50% of the site, running back into sandy loam soil (Fig. 37).

**Disonycha alternata**

The study on *Disonycha alternata* was carried out in two parts. The first consisted of laboratory rearing of the beetles. The second consisted of field studies made to supplement the laboratory work.

**Laboratory** - Laboratory rearing was carried out in late spring and summer of 1970. Specimens of *D. alternata* were collected on *S. interior* along the Missouri River near Elk Point, South Dakota. A laboratory colony was started with these beetles, but due to improper rearing techniques, the adults of the colony died out. A second attempt was made to start a colony with beetles collected from site A-100. This attempt met with greater success. *Salix interior* was
used as a food source for *D. alternata*. The food was handled as was done for *Altica subplicata*.

Three types of rearing containers were used, as was done with *A. subplicata*. In the type I containers 7-10 pairs of adult *D. alternata* were placed and allowed to lay eggs for 2 or 3 days before being transferred to a new container. At this time, all old plant wastes were removed. Because *D. alternata* normally lay their eggs in the ground, it was necessary to use care in handling the old containers so that the sand was not disturbed. After the eggs hatched, fresh willow was again placed into the containers daily. Stale willow was cleaned from the containers every 5-7 days. The larvae moved from the old willow to the new by themselves, thus shortening the time required for cleaning. After the larvae entered pupation, the containers were again cleaned. Nothing more was done with them until the adults began to emerge. Newly emerged adults were transferred into new containers.

Most of the *D. alternata* data was obtained from the type II container. These containers were set up similarly to those used for *A. subplicata*, but were cared for differently. One willow shoot with 2 or 3 leaves was placed into each container and one pair of beetles was introduced for the purpose of egg laying. After one day, the pair was transferred into a new container, the stale willow was removed, and the jar put aside with its contents intact. By continuing this procedure, of daily moving the mated pair into a new container, a series of jars was obtained. These were placed on a shelf in chronological order, and each day observations were recorded. After the eggs hatched, fresh willow shoots were introduced. Any containers that did
not contain young larvae after 15 days were cleaned and the sand was checked for egg deposits. The larvae were given fresh willow every day and the containers were cleaned every 2 or 3 days. Toward the end of the second instar, the larvae from certain single containers had to be moved into 2 or 3 new containers to prevent over-crowding. After pupation, the stale willow was again removed from the containers. Emerging adults were removed and placed into different containers. Samples of eggs, larvae, pupae, and adults were taken throughout the study and preserved in 70% alcohol.

The type III container was used for instar determination. Procedures were the same as those used with A. subplicata. Originally these containers were set up with a piece of sponge in the bottom to hold moisture. However, it was noted that the larvae were not pupating properly and it was not until the sponge was exchanged for a teaspoon of sand, that the larvae would pupate normally.

For information on rearing area and temperature see A. subplicata.

Field Work - Field work for D. alternata was comparable to that done for A. subplicata.
RESULTS AND DISCUSSION

Larval Morphology

This section is prepared as a contribution to the characterization of larval Alticinae. Complete descriptions of the larvae of Altica subplicata and Disonycha alternata are presented which indicate distinction between their genera.

Two papers were found dealing with the numbering of tubercles and setae of coleopterous larvae, Sanderson (1901) and Wood (1918). Sanderson dealt mainly with tubercles and made no allowance for individual setae. Wood, not agreeing with Sanderson's homologizing of various tubercles, set up his own tentative system for numbering the setae. As neither system was satisfactory for this study, a purely hypothetical system of arbitrarily numbered sclerites and setae was used which made descriptive work much easier. This system is not intended for comparative studies. Setal maps are provided for clarification of the descriptions (Fig. 4, A. subplicata; Fig. 5, D. alternata).

Altica subplicata

(Described from a series of 20 full grown larvae, preserved in alcohol; adults collected in Union Co., South Dakota; reared on Salix interior R.)

Full grown larvae - length 6.25 mm - 10.25 mm, mean length 8.50 mm; greatest width 1.50 mm - 1.95 mm, mean greatest width 1.79 mm. Larvae carabiform, fusiform with chalazae on margin giving serrate
appearance; sides tapering slightly anteriorly and posteriorly from metathorax. Legs cylindrical and angulate; body segments, except for prothorax and 9th and 10th abdominal segments, with small, irregularly placed, deeply pigmented sclerites bearing chalazae. All segments distinct and, with exception of prothorax and 9th and 10th abdominal segments, having 2 intrasegmental transverse bands. Body setae short to moderately long, distinctly pointed and usually borne on chalazae. Interscleritic membrane deeply pigmented dorsally, moderately so ventrally. Body membrane ivory white, shagreened with numerous minute brown sclerites (Fig. 6-8).

Head (Hd) hypognathus, appearing circular as seen from anterior end, shining brownish-black, with a light brown area dorsad of each antennal socket, and a white line extending along coronal suture to ½ way down frontal sutures. Epicranial suture (Eps) distinct. Coronal suture short, with long frontal sutures extending to antennal sockets. Frons (F) large, roughly forming an equilateral triangle. Frontal endocarina 1 (FeC) present, externally observable as a dark line running from juncture of coronal and frontal sutures to center of fronto-clypeal suture; 'Y' shaped endocarinal side arms attached to line, forming oblique angle dorsally. Junction of arms located slightly below center of frons, closely associated with circular frontal depression (Fig. 13). Frons bearing 6 setae, 3 on each side of mid-line arranged in triangle; dorsal-most seta located in lower arm of 'Y'

1 The term "endocarina" here designates the internal ridge, often found in coleopterous larvae, which extends along the mid-line of the frons (After Anderson, 1958).
shaped endocarinal side arm; second seta located below 1st, \( \frac{1}{2} \) the distance between 1st and fronto-clypeal suture; third seta located laterad of 1st and 2nd, near antennal socket (Fig. 13). Lateral portion of cranium dorsad of antennal socket, bearing 5 setae; 3 of which located dorsad from antenna, 2 times distance across antennal socket from antennae, in straight longitudinal line; fourth seta located dorsad of 3 setae in line, at apex of equilateral triangle formed with 1st and 2nd setae; fifth seta located dorso-mediad to 4th (Fig. 13). Gena bearing 4 setae; three large setae forming triangle—2 dorsal and 1 ventral; 1 small seta located in center of triangle. Ocelli absent. Clypeus (Cly) 4\( \frac{1}{2} \) times as broad as long, consisting of 2 parts, a distal membranous portion and a proximal scleritic portion; distal portion twice as large as proximal; proximal portion scleritized and narrow, laterally 1/3 width of clypeus tapering to fine line medially. Proximal portion of clypeus bearing 2 lateral setae (Fig. 13). Labrum (Lb) 4 times as broad as long, narrower than clypeus, narrowing distally with distal margin notched; with 4 setae, evenly spaced across front (Fig. 13). Fronto-clypeal and clypeo-labial sutures distinct. Antennae (Ant) short, 2 segmented; first segment consisting of large scleritized ring; second segment consisting of 1 scleritic ring encircling 2 sensory appendices unequal in length. Mandibles (Md) dark brown and palmate. Left mandible over-laps right. Inner surface concave with 5 teeth. Length of teeth in decreasing order 3-2-1-4-5. Mandible with 2 setae near outer proximal edge (Fig. 18). Scleritized portions of maxilla dark brown. Cardo (Cd) triangular, bearing 1 well developed seta in its lateral angle. Stipes (St) nearly square at
proximal end; distal margin in form of 'J' with long arm reaching to lacina. Stipes bearing 2 setae, 1 located on tip of short arm of 'J'; 1 located proximally to 1st, \( \frac{1}{2} \) the distance to proximal edge. Palpifer (Pf) present as separate, narrow, rectangular, sclerite curved around base of maxillary palpus; located within 'J' formed by stipes. Palpifer bearing 3 well developed setae along its distal edge. Maxillary palpus (Mx) 3 segmented, bearing 2 setae on distal edge of second segment; first and second segments broad and ring shaped, second segment smaller than first; third segment cone-shaped. Galea (ga) well developed; base formed by inverted triangular sclerite with 2 points curved around to form a circle. Membranous center of galea bearing 6 short spines, 1 in center and 5 forming outer ring. Lacina (la) consisting of a highly scleritized bar with lacinal brush on distal edge; hidden behind galea (Fig. 16, 20). Labium (Prm-Ptm) separate from maxilla. Distal portion prelabium (Prm) triangular, with extremely rounded corners. Labial palpi (Lp) 2 segmented; 1 located at each proximal angle of triangle. Proximal portion of prelabium appears as narrow, transverse sclerite delineating proximal limits of prelabium; transverse sclerite with 2 well developed setae. Postlabium (PtM) covered by lightly pigmented sclerite, wider at base than at distal edge; distal angles slightly elongated and curved under at corners of prelabial sclerite. Postlabium bearing 4 well developed setae; 2 setae near proximal edge of sclerite, 2 located mesad to first 2, \( \frac{1}{2} \) the distance to distal edge of sclerite (Fig. 15).

Nine pair of spiracles (Sp) present; 1 pair on mesothorax and 1 pair on abdominal segments 1-8. Metathorax with vestigial spiracle
appearing as a dark spot. Spiracular openings, circular.

Prothorax (Pt) \(1\frac{1}{2}\) times as wide as long. Prothoracic shield (Pts) brown, with brownish-black spots patterned across surface; divided along dorsal meson by white line. Prothoracic shield, viewed from above, pointed laterally; appearing as elongated hexagon. Surface moderately grooved laterally. Shield bearing 16 setae; 10 setae evenly spaced forming transverse line along anterior margin, 6 setae forming transverse line \(2/3\) distance from cephalic margin (Fig. 4). First pleural sclerite (p1) elliptical, antero-posteriorly oriented, located posterio-laterally on prothorax; with central chalaza bearing 1 seta.

Second pleural sclerite (p2) located antero-dorsad to coxa with chalaza located dorsad and bearing 1 seta.\(^2\) Third pleural sclerite (p3) located posterio-dorsad from coxa, with no chalaza present; bearing 1 dorso-lateral seta (Fig. 4). First sternal sclerite (s1) flat; as long as wide, tapering anteriorly; straddling ventro-medial line. Sclerite bearing 4 setae; 1 pair of setae located on axis of line drawn between center of coxae; 1 pair located posterior to first, \(\frac{1}{2}\) distance between first pair and posterior margin of sclerite (Fig. 4).

Mesothorax (Ms) 2 times as wide as long. First tergal sclerite (t1) 3 times as wide as long, located on anterior intrasegmental band and divided by white line running along dorso-meson. One chalaza located in center of each \(\frac{1}{2}\) of sclerite, bearing 1 seta. Second tergal sclerite (t2) located on posterior intrasegmental transverse band, similar to t1 but not as wide. Third tergal sclerite (t3) round, located

\(^2\)This sclerite appears to be homologus with Sailsbury's (1943) episternum.
ventrad and slightly anterior from t1; slightly convex with no setae.

Fourth tergal sclerite (t4) eliptical; dorso-ventrally oriented; located ventrad from t2. Two chalazae located on dorso-ventral line in middle of sclerite, each bearing 1 seta (Fig. 4). First pleural sclerite (p1) kidney shaped; with large, central, dorso-ventrally compressed chalaza; chalaza bearing 3 large setae arranged in form of flattened triangle – 2 dorsal and 1 ventral; sclerite antero-posteriorly oriented, located dorso-laterally on mesothorax. Second pleural sclerite (p2) eliptical; dorso-ventrally oriented; located antero-laterad from p7. Sclerite with 1 chalaza located dorso-medially, bearing 1 seta. Mesothoracic spiracle located on p2 on posterio-ventral slope of chalaza. Third pleural sclerite (p3) eliptical, antero-posteriorly oriented, located posterio-laterad from p1; with 1 chalaza located antero-laterad on sclerite, bearing 1 seta. Fourth pleural sclerite (p4) smooth, convex and without setae; located antero-dorsad from coxa.

Fifth pleural sclerite (p5) similar to p3 of prothorax. Sixth pleural sclerite (p6) small, round and flat; without seta; located anterior to coxa, below p2 (Fig. 4). First sternal sclerite (s1) small and flat; 2 times as wide as long; straddling ventro-medial line on anteriormost edge of mesothorax. Second sternal sclerite (s2) large, transversely oblong and flat; located anterior to axis of line drawn between center of coxae; with 2 setae – 1 on each side of mid-line.

Third sternal sclerite (s3) small, round and flat; located caudad and slightly laterad from s2; bearing 1 central short seta.

Metathorax (Mt) similar to mesothorax with following exceptions: third tergal sclerite (t3) slightly larger and notched dorsally.
Second pleural sclerite (p2) with vestigial spiracle, visible as a small black spot; chalaza and setae located ventrally on sclerite. Sixth pleural sclerite (p6) divided into 2 small sclerites, one located posterior to other (Fig. 7).

Legs well developed, consisting of coxa (Cx), femur (Fe), tibiotarsus (T-T), a claw (cl) and a pulvillus (pu). Legs increasing in size from prothoracic leg to metathoracic leg. Coxae articulate with p2 on prothorax and p4 on mesothorax and metathorax. Dorsal portion of coxa with lightly pigmented triangular area. Femur lightly pigmented ventrally, bearing 4 setae; trochanter fused to femur. Femur and tibio-tarsus round in cross section; tibio-tarsus tapering distally. Claw wide proximally, narrowing distally and curving ventrally; with 1 tooth. Pulvillus filling area ventrad from claw, not extending beyond claw (Fig. 17).

Abdominal segments 1-7 similar. First tergal sclerite, 3 times as wide as long; located on anterior intrasegmental transverse band; straddling dorso-medial line. Sclerite with 1 chalaza located in center of each ½ of sclerite; each chalaza bearing 1 seta. Second tergal sclerite (t2) located on posterior intrasegmental transverse band, similar to t1 but not as wide. Sclerites t3-t6 all similar. Sclerites oval with 1 chalaza located centrally, each bearing 1 seta. Third tergal sclerite (t3) and t5 located in order on anterior intrasegmental transverse band ventrad from t1; t4 and t6 located in order on posterior intrasegmental transverse band ventrad from t2 (Fig. 4). First pleural sclerite (p1) more or less pear-shaped, smaller then tergal sclerites; located on division line between anterior and
posterior intrasegmental transverse bands dorsad of lateral margin; sclerite flat, bearing 1 spiracle slightly dorsad of center (Fig. 4). First sternal sclerite (s1) large and oblong; oriented antero-posteriorly, length greater than \( \frac{1}{2} \) width of segment; sclerite with 1 large chalaza situated caudad on sclerite; bearing 3 setae—2nd located caudad on sclerite, 1st located antero-ventrad from 2nd; both situated on chalaza. Third seta small, located on antero-dorsal slope of chalaza, near edge of sclerite. Second sternal sclerite (s2) oblong-oval, smaller than s1; located ventrad from s1, lying along axis of line drawn antero-posteriorly through centers of coxae. Small chalaza located posteriorly on sclerite, with 2 setae; first seta (4) located centrally; second seta (5) located dorso-posterior to 1st. Third sternal sclerite broadly oblong-oval; located antero-medially, straddling ventro-medial line; sclerite with 2 setae—one on each side of mid-line. Fourth sternal sclerite oval, located caudad from dorsal edge of s3; dorso-ventrally oriented, \( \frac{1}{2} \) distance between s3 and posterior margin of segment. Sclerite distinctly convex, bearing 2 setae on axis of dorso-ventral line (Fig. 4).

Eighth abdominal segment similar to segments 1-7 with these exceptions: Sclerites t2 and t4 fused into single oblong sclerite; setae borne on ridge.

Ninth abdominal segment, viewed dorsally, nearly square; \( \frac{1}{2} \) width of 8th abdominal segment. Heavily scleritized anal shield present. Posterior margin of shield turned ventrally; large transverse depression present near posterior edge of shield causing formation of distinct posterior ridge. Ridge bearing 8 setae—setae 1-3-6-8 directed
dorso-caudal; setae 2-4-5-7 directed ventro-caudal. Two setae located
discal on anal shield, anterior to anal shield depression. Ninth
abdominal segment with 1 sternal sclerite; 3 times as wide as long,
straddling ventro-medial line; with 4 setae in transverse line — 2
located on each side of mid-line equal distance apart (Fig. 6-8).

Tenth abdominal segment small, narrow and cylindrical; bearing no
setae or chalazae; terminating in white, membranous pygopyle. Anal
opening 'Y' shaped (Fig. 8).

Differences in 1st stadium: Number 3 seta usually absent from s1
sclerite on abdominal segments 1-8 and seta number 8 on s4; eighth
abdominal segment vestigial. Sclerite p6 on mesothorax and metathorax
absent.

Differences in 2nd stadium: Number 3 seta usually absent from s1
sclerite on abdominal segments 1-8. Sclerite p6 on metathorax not
divided.

Disorycha alternata

(Described from a series of 20 full grown larvae preserved in
alcohol; adults collected in Brookings Co., South Dakota; reared on
Salix interior R.)

Full grown larvae — length 9.36 mm - 11.65 mm, mean length 11.10
mm; greatest width 2.30 mm - 2.70 mm, mean greatest width 2.48 mm.
Larvae carabiform, fusiform. Pterothorax and abdominal segments 1-5
approximately same size. Sides tapering slightly anteriorly from meso-
thorax; tapering posteriorly from 5th abdominal segment. Eighth, 9th
and 10th abdominal segments curving ventrally; legs cylindrical and
angulate. Body segments nearly void of sclerites. All segments distinct, without intrasegmental bands. Body membrane shagreened with minute brown sclerites; base color, ivory. Body segments with deeply pigmented areas on dorsal and pleural aspects; lightly pigmented ventrally. Darkened tergal area on all segments and darkened pleural area on abdominal segments rugosely ridged due to bunching up of body membrane into folds. All tubercles on larvae cone-shaped, membranous and bearing 1 seta; all cones ivory, with circular, pigmented ring at base of each seta (Fig. 9-11).

Head (Hd) hypognathus, appearing circular as seen from anterior end; generally brownish-black with some light areas present. Large lyre-shaped area on frons, oval area above ocelli and all of genal areas pale yellow-brown; epicranial suture with white line extending along coronal suture to \( \frac{1}{3} \) way down frontal sutures. Epicranial suture (Eps) distinct along entire length; coronal suture extending \( \frac{1}{3} \) distance down cranium from vertex (V). Frontal sutures extend downward from juncture with coronal suture, toward antennae and turn outward at point mid-way down cranium; continuing laterally to point \( \frac{1}{2} \) way between juncture of frontal sutures and ocellus, there curving ventrolaterad again ending at caudal margin of antennal socket. Frons (F) large, roughly pentagonal; having 2 long sides the length of the frontal sutures, and 2 short sides, an imaginary line between dorsal-most point of antennal socket and lateral-most point on fronto-clypeal suture; fronto-clypeal suture forming 5th side, approximately \( 2\frac{1}{2} \) times length of 1 short side; long sides approximately \( 3\frac{1}{2} \) times length of 1 short side (Fig. 12).
Frontal endocarina\(^3\) (FeC) present, externally observable as a dark line extending from juncture of frontal sutures and coronal suture to center of fronto-clypeal suture; with 2 side arms, attached obliquely at point where imaginary line drawn between 2 dorsal-most points on antennal sockets crosses dorso-ventral line. Endocarina closely associated with large, triangular frontal depression (Fig. 12). Frons bearing 6 setae—three on each side of mid-line, arranged in a triangle; dorsal-most seta (1) of each triangle located above endocarinal arm, dorsad of lateral margin of clypeus and mesad of lateral ocelli; 2nd seta located near antennal socket, on imaginary line extending laterad from endocarinal side arm; 3rd seta located on lower frontal ridge, mesad of 2nd, \(\frac{1}{2}\) distance between 2nd seta and mid-line; distance between 1st and 2nd setae 1\(\frac{1}{2}\) times that between 2nd and 3rd. Lateral portion of cranium, dorsad of antennal socket, bearing 4 setae—2 dorso-mesad from ocellus and 2 posterio-laterad from ocellus. First seta (1) located posterio-ventrad to ocellus; 2nd seta located dorsad of 1st, caudad from ocellus; 3rd seta located on transverse line drawn through 2 dorsal-most setae on frons, dorsad of antenna and dorso-mesad of ocellus; 4th seta dorsad and slightly laterad of latero-ventrad bend in frontal suture, located equidistant from both 3rd cranial setae and 1st frontal setae. Lateral portion of cranium below antennae bearing 2 setae located on anterio-posterior line posterior and slightly ventrad of antennae, forming base of equilateral triangle with 1st

\(^3\)The term "endocarina" here designates the internal ridge, often found in coleopterous larvae, extending along the mid-line of the frons (after Anderson, 1938).
cranial seta. One ocellus (Oc) present, situated anterio-laterad on the cranium, posterio-dorsad from antenna. Clypeus (Cly) 4 times as broad as long, tapering distally; consisting of 2 parts—a small heavily scleritized proximal portion and a larger lightly scleritized distal portion; lateral edge of proximal piece 1/3 width of distal piece, tapering to fine line medially; proximal portion bearing 2 lateral setae (Fig. 12). Labrum (Lb) 2 times as broad as long, approximately equal in width with clypeus; tapering distally with distal margin notched; with 4 setae, evenly spaced across front—lateral pair of setae slightly proximal from medial pair (Fig. 12). Frontoclypeal and clypeo-labial sutures distinct. Antennae (Ant) short, 2 segmented; located anterio-ventrally on head, dorsad of mandibular articulations; encircled by membranous collar extending from edge of antennal socket. First segment consisting of large scleritized ring; second segment bearing 1 lateral sensory appendix and 1 central cone-shaped papilla. Mandibles (Md) brown and palmate. Right mandible over-laps left. Inner surface with circular depression, bearing 5 teeth distally. Length of teeth in decreasing order 2-3-4-1-5, 5 being little more than a ridge up against inside edge of 4. Mandible bearing 2 setae—1 near proximal edge, 1 distad of 1st (Fig. 21).

Maxillary sclerites dark brown. Cardo (Cd) small, triangular and very convex with minute vestigial seta in lateral angle. Stipes (St) nearly square at proximal end and concave; distal margin in form of 'J' with long arm extending to lacina; bearing 2 setae—1 located on tip of short arm of 'J' and 1 located proximal to 1st, 1/2 distance to proximal edge. Palpifer (Pf) present as separate, narrow sclerite, curving
around base of maxillary palpus located with 'J' formed by stipes; scolride with 2 setae located on meso-distal aspect. Maxillary palpi 3 segmented, bearing 2 small setae on distal edge of second segment; first and second segments broad and ring shaped, second smaller than first; third segment cone-shaped. Galea (ga) well developed; base formed by inverted triangular sclerite with 2 dorsal angles curved around to form a circle; membranous center bearing 1 spine and 1 cone-shaped papilla, center ringed with 5-7 short spines. Lacina (la) triangular, lightly pigmented sclerite with distal lacinal brush (Fig. 19, 22). Labium (Prm-Ptm) separate from maxilla. Prelabium triangular and membranous, bearing short spines centrally on membrane. Labial palpi (Lp) 2 segmented – 1 located at each lateral angle of triangle. Proximal portion of prelabium consists of a narrow, transverse sclerite which delineates dorsal limit of prelabium, sclerite curving around lateral margins of prelabium, bearing 2 setae. Postlabium (Ptm) covered by lightly pigmented sclerite which is wider at base than at distal edge, lateral margins curved under stipes, distal angles slightly elongated and curved under at corners of prelabial sclerite; sclerite bearing 6 setae – 1 pair near latero-ventrad margin of sclerite; second pair located mesal to first pair, \( \frac{3}{2} \) distance down sclerite; third pair, smaller than first 2 pair, located latero-ventrad of second pair (Fig. 14).

Nine pair of spiracles (sp) present; 1 pair on mesothorax and 1 pair on abdominal segments 1-8. Metathorax with vestigial spiracles, appearing as a short dark line. Spiracular openings, circular.
Prothorax (Pt) 2 times as wide as long, extremely tuberculate with no scleritized prothoracic shield present. Dark pigmented tergal area with transverse ridging; pigmented area extending onto pleuron. Tergum of prothorax bearing 16 tubercles; 10 evenly spaced, along cephalic margin, forming double transverse row - 6 in 1st row (t1-t5-t8 respectively, Fig. 5) and 4 in 2nd row (t3-t7 respectively, Fig. 5). Six tubercles located on posterior area of prothoracic tergum - 3 on each side of mid-line; second tergal tubercle (t2) centrally located on prothorax, slightly laterad of mid-line; fourth (t4) and sixth (t6) tubercles evenly spaced, on line extending posterio-laterad from t2, with t6 directly posterior to t7 (Fig. 5). Pleural tubercles p1-p2-p3 grouped together on lateral aspect of segment, p2 slightly ventrad of p1 and p3. First pleural sclerite (P1) associated directly with 4th pleural tubercle (p4), forming part of posterior side of 4th tubercle; sclerite located antero-dorsad of coxa, forming articulation with coxa.\(^4\) Fifth pleural tubercle (p5) slightly smaller than other pleural tubercles; located dorsad of coxa and directly ventrad of P1. Sixth pleural tubercle (p6) much smaller than other prothoracic tubercles, comparable to t3 on mesothorax; seta short and without pigmented ring at base; tubercle located slightly below p1, approximately equidistant from p1 and p2 (Fig. 5, 10). First sternal sclerite (S1) small and oval; located anteriorly on prothorax and straddling ventro-medial line. Second sternal sclerite (S2) small, round and flat, with short central setae; located \(\frac{1}{2}\) distance between S1 and S3, laterad from

\(^4\)This sclerite appears to be homologous with Sailsbury's (1943) episternum.
lateral margin of S1. Third sternal sclerite (S3) small, oval and flat, smaller than S1; located on posterior margin of prothorax, straddling ventro-medial line (Fig. 5).

Mesothorax (Ms) $2\frac{1}{2}$ times as wide as long. Tergal aspect darkly pigmented with rugose ridges running transversely across darkened area of segment. Tergum bearing 6 tubercles in transverse line – 3 on each side of mid-line. First tergal tubercle (t1) located centrally on tergum, slightly laterad of mid-line. Second tergal tubercle (t2) located centrally between prothorax and metathorax, $\frac{1}{2}$ distance between t1 and lateral margin of segment. Third tergal tubercle (t3) $\frac{1}{4}$ size of t1, more rounded than other tubercles; seta short and lacking pigmented ring at apex. First pleural sclerite (P1) round and conical, located anterio-laterad on segment and bearing mesothoracic spiracle. First pleural tubercle (p1) and p2 grouped together p1 slightly anterio-ventrad of p2; located posterio-dorsad of P1 and between tergal and pleural pigmented areas. Third pleural tubercle (p3) located anterio-ventrally, directly below P1, $\frac{1}{2}$ distance between P1 and P2. Fourth pleural tubercle (p4) located directly caudad from p3 on line drawn between p2 and center of coxa, $\frac{1}{2}$ distance between p2 and p5. Second pleural sclerite (P2) large, flat and mitten-shaped, with large portion situated anteriorly and finger oriented dorsally; located dorso-anterior to coxa; lower margin of sclerite articulating with coxae. Fifth pleural tubercle (p5) smaller than p1 and p4, located directly ventrad of P2, dorsad and slightly caudad of coxa (Fig. 5). First sternal sclerite (S1) small, round and flat, with short seta located centrally; located on line drawn between centers of coxae, 2
times its own width laterad from ventro-medial line. Second sternal sclerite (S2) oblong-oval and slightly larger than prothoracic S3, located on posterior edge of segment, straddling ventro-medial line (Fig. 5).

Metathorax similar to mesothorax with following exception: Metathorax without P1 sclerite, only vestigial spiracular spot remaining.

Legs well developed; consisting of coxa (Cx), femur (Fe), tibiotarsus (T-T), a claw (cl) and a pulvillus (pu). Mesothoracic and metathoracic legs equal in size, prothoracic legs slightly smaller. Coxae articulate with P1 on prothorax and with P2 on mesothorax and metathorax. Dorsal portion of coxa with lightly scleritized triangular area. Femur lightly pigmented ventrally, bearing 6 setae. Trochanter fused to femur. Femur and tibio-tarsus round in cross section. Tibiotarsus abruptly tapered distally. Claw wide proximally, narrowing distally and curving ventrally; with 1 tooth. Pulvillus filling area ventrad from claw, not going beyond claw (Fig. 23).

Abdominal segments 1-7. Segment 2-2½ times as wide as long. Tergal aspect darkly pigmented with rugose ridges transversely oriented across segment. Tergum bearing 6 setae – 3 on each side of mid-line. Four of 6 tergal tubercles (t1 and t3 on each side respectively, Fig. 5) located on transverse line extending across central tergum; first tergal tubercle (t1) located medially and slightly laterad of dorso-medial line; second tergal tubercle (t2) and t3 grouped together on dorso-lateral aspect of segment; (t3) located latero-ventrad from t1 and t2 located caudad and slightly dorsad from t3 (Fig. 5). First pleural sclerite (P1) small, round and conical, bearing spiracular
opening centrally and located medio-laterally on segment (Fig. 5). First sternal tubercle (s1) located centrally on segment, posterior-ventrad from P1. Second sternal tubercle (s2) similar in size to mesothoracic p5; located medially on segment, on axis of anterio-posterior line drawn along dorsal margin of coxae. Sternum bearing 4 sclerites - 2 on each side of mid-line (S1-S2), located on transverse line across sternum; sclerites small, round and flat with 1 short central seta on each. First sternal sclerite (S1) located centrally on sternum, 2 times its width laterad from ventro-medial line; second sternal sclerite (S2) located laterally on transverse line, 2 times its width from S1 (Fig. 5).

Eighth abdominal segment similar to segments 1-7 with these exceptions: First sternal tubercle (s1) caudad and slightly ventrad from P1. Second sternal tubercle s2 from abdominal segments 1-7 absent on 8. First sternal sclerite (S1) oval and flat, dorso-ventrally oriented and bearing 2 setae on transverse line. Third sternal sclerite (S3), new sclerite; narrow, oblong and flat, antero-ventrally-posterio-dorsally oriented; located posterio-dorsally from S1 (Fig. 5).

Ninth abdominal segment, viewed dorsally, 3 times as wide as long. Heavily scleritized anal shield present, bearing 16 setae in 2 transverse rows - 10 setae pointing caudally on posterior margin and 6 setae uniformly spaced in transverse line, 3 on each side of mid-line. Ninth abdominal segment with 1 sternal sclerite 3 times as wide as long; bearing 4 setae - first pair located directly caudad from center.

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* Eighth abdominal sclerite (S8) appears to be a combination of sclerites similar to S1 and S2 on abdominal segments 1-7.
of S1 sclerites on 8th abdominal segment; second pair located posterior-laterad from first pair, on lateral margin of sclerite (Fig. 9-11).

Tenth abdominal segment much reduced, consisting of a small, narrow, cylindrical sclerite, bearing no setae or tubercles. Segment terminating in a white, membranous pygopyle. Anal opening located in pygopyle (Fig. 10-11).

First instar similar to 3rd with these exceptions: Sixth pleural tubercle (p6) on prothorax absent. Third tergal tubercle (t3) on mesothorax and metathorax present as a small dark tubercle, without seta.

Second instar similar to 1st with this exception: Third tergal tubercle (t3) on mesothorax and metathorax somewhat obscure, present only as slight rise on cuticle.
Life History

The following results and observations, unless otherwise stated, were obtained from beetles reared in the laboratory. Since this work was done under artificial conditions, it cannot be assumed that the results obtained can be directly correlated with what actually occurs in the natural environment.

*Altica* subplicata

*Laboratory* - *Altica* subplicata produce 2 generations annually under laboratory conditions. The beetles pass through 3 larval stadia per generation and probably overwinter as adults. Total cycle from egg to adult takes approximately 34 days. The data on *A. subplicata* larval stadia are scanty and might not always prove true for larger numbers of beetles.

Description of Stadia:

Description of egg, based on examination of 20 eggs - nearly cylindrical with both ends rounded and slightly truncate. Length 1.20 mm; diameter at greatest width 0.49 mm. Surface of egg minutely sculptured, having a honeycombed appearance; sculpturing consists of small ridges dividing cuticular surface into polygonal areas, areas between ridging distinctly impressed, with fine punctuation occurring within. Color of eggs dark yellow and glossy when freshly laid; turning to tannish-orange after a few hours (Fig. 28).

Description of first larval stadium - See discussion of larval morphology of *A. subplicata*; note first stadium differences. Newly
hatched larvae smooth and shiny black, slightly longer than egg upon hatching, growing to twice the length of the egg within 24 hours after emerging. Late instar larvae with body distended; interscleritic membrane light brown, sclerites appearing black. Length of first instars 1.50 mm - 3.75 mm; head capsule width 0.42 mm (Fig. 39).

Description of second stadium larvae - See discussion of larval morphology of A. subplicata; note second stadium differences. Newly ecdysed larvae light cream colored immediately upon hatching, changing to normal pigmentation within 6 hours after molt. General color of sclerites brownish-black, interscleritic membrane olive-brown; ventral surface brownish-yellow with brown sclerites. Late instar larvae with body distended; all colors similar to early instar, but generally lighter. Length of second instars 3.75 mm - 6.87 mm; head capsule width 0.62 mm - 0.72 mm (Fig. 39).

Description of third larval stadium - See discussion of larval morphology of A. subplicata. Newly ecdysed larvae cream colored immediately upon hatching, changing to normal pigmentation within 6 hours after molt. Length of third instars 6.25 mm - 10.40 mm; head capsule width 0.92 mm - 1.05 mm (Fig. 39).

Prepupae - Prepupal stages are described for many of the Altica spp., viz. A. ambiens alni, A. torquata, A. corni, A. rosea, A. ulmi (Wood, 1917; Wood, 1918). Likewise, Dirks-Edmonds (1965) indicates that a prepupal period exists in A. tombacina, although she does not label it as such. It is probable, therefore, that a prepupal stage

\[\text{Actual value not known. This figure, 3.75 mm, is an approximation.}\]
exists for *A. subplicata*. However, none was observed in this study.

Description of pupae - similar in size and general shape to adult. Color pale yellow to bright yellow. Many setae on pupa homologous to those on third instar larvae. Prothoracic setae and many setae on abdominal segments 7-9 homologous with those on larvae. Some setae on lateral aspects of pupa raise questions as to homologies (Fig. 25-27).

Description of adult - length 5.0 mm - 6.2 mm; body oblong, nearly parallel; dorsal surface alutaceous, moderately shining and distinctly metallic blue to purple. Antennae piceous, \( \frac{1}{2} \) as long as body with segments 2-3-4 gradually increasing in length. Head with frontal carina present and obtuse, tubercles well marked, punctures extend across head above tubercles near eyes. Prothorax \( 1\frac{1}{2} \) times as wide as long, narrowing anteriorly; sides slightly arcuate, margin narrow, transverse basal impression shallow, limited at sides; surface distinctly alutaceous, lightly punctate, with punctures more distinct near apex. Elytra distinctly wider at base than at thorax; humeri short; surface dull alutaceous, finely and indistinctly punctate; umbone prominent with lateral plica starting at umbone and extending caudad, parallel with margin; elytral costa not wide or well marked, margin not obscured by elytral fold, elytra smoothly convex without prominent callosities or depressions. Aedeagus smooth and venter not sculptured, possessing few apical impressions (Fig. 32).

Description of molting - Ecdysing in all stadia, from first instar through pupae, is quite similar. The old cuticle is split longitudinally along the dorsal aspect, from the vertex on the head capsule
caudally along the medial line, to the second or third abdominal segments. In the larval stages, the larvae first attach themselves to the substrate by their anal glands. Then, through extension and contraction, the thorax and head are extracted from the cuticle. Shortly following this, the legs are freed and the larvae stop to rest for a short time. After several preliminary movements, the larvae release their anal gland and walk out of their old exuviae. The pupae were more difficult to observe, but the ecdysing process appeared to be basically the same. The only differences noted were that the pupae do not attach to their substrate, and they remove themselves from the old cuticle entirely by the process of extension and contraction. It appears to be exceptionally important for the pupa to extract its head entirely from the exuvia. Four individuals were observed with their larval skin still attached at the head and legs. Although the rest of their bodies were free, all 4 pupae died before the adults emerged.

Biological History:

Eggs - laid singly or in clusters of 2-21, the mean number being 10 eggs. The eggs are laid horizontally on the leaves of the host plant, usually on the ventral surface, with successive rows of eggs over lapping. Often the eggs will have a streak of excrement located dorsally. If the beetles were disturbed prior to or during egg laying, either for transferring the beetles or cleaning the containers, the egg laying pattern was usually interrupted. The beetles would either stop laying for a day, or the eggs would be scattered throughout the container rather than being laid in the normal small clusters. Out of
a test sample of 467 eggs, 29 were infertile. The fertile eggs hatched in 6-9 days, with a mean incubation period of 7.0 days.

Larvae - Based on approximately 100 larvae; the total number of days required from hatching to pupation were 15-17 days, with the mean being 16.5 days. Information on the *A. subplicata* stadia is scanty. The figures used were taken from small and sometimes incomplete samples, since both instar determination tests failed. One test failed due to disease and the second due to improper handling. The stadia data given here is based on 7 larvae; 1st stadia, 4 days; 2nd stadia, 4-5 days; 3rd stadia, 7 days. The totals are 15 and 16 days, respectively and both fall within the determined range. Laboratory larvae were fed *Salix interior*, the host plant from which the adults were taken, and they appeared to thrive on it. Two types of typical larval feeding damage inflicted on the willows were observed in the laboratory. The first type is skeletonization of the leaves by first and early second instar larvae. In this type of damage, the outer cuticle and inner mesophyll of the leaf are eaten away from one side, leaving only the epidermal cuticle of the leaf on the opposite side. This gives the leaf a 'shot hole' appearance (Fig. 34). The larvae can eat through from either side, but the underside seems to be preferred. The second type of damage is caused by later instar larvae and adults feeding from the side of the leaf. These insects eat away the entire margin of the leaf and occasionally feed all the

7Pupation here refers to the time at which the larvae burrow into the sand. The prepupal period is therefore included under pupation.
way through to the mid-rib. Examples of extreme damage can be seen in Fig. 35.

Pupae, based on 35 pupae — larvae form pupal cells prior to pupation; the cells are formed from mucus secreted from the maxillary glands (Wood, 1917). Ten-13 days are spent in the pupal stage, with a mean of 12.0 days. After ecdysing, the new teneral adult remains underground for 1-2 days before emerging. The newly ecdysed adults are pale, greyish-white, with some dark color present in the mandibles, eyes, tarsi, and various sutures and angles. Color next appears on the body in the head, antennae, distal femur, coxae, last abdominal segments, dorsal prothorax and the angles at the base of the elytra. When the teneral adults emerge from the ground, they are fully colored, but color is light and the body still soft (Fig. 25, 27).

Adults — Adults used to start the colony were obtained on May 27, 1970, from *Salix interior* growing along the Missouri River, southwest of Elk Point, South Dakota. Adult pairs were in copulation on the date of collection, but were not yet laying eggs. First eggs were laid on June 4th; first larvae hatched on June 11th; larvae entered pupation on June 26th; first adults emerged on July 8th; the total period encompassed 34 days from egg to adult. The total time period from egg to adult ranged from 31-37 days with a mean of 34.0 days. Second generation adults, from the same parent stock, were tested to determine the time required for the emerging adults to begin laying eggs. Adult beetles emerging on July 9th were used in this study.
Riding was first observed July 19th and copulation took place on July 21st. The time elapsed from emergence to mating was 12 days and the total time from emergence to egg laying was 24 days.

Two tests were run to determine the number of eggs laid by *A. subplicata*. The first test was conducted with 8 pair of first generation adults and the second test was conducted with 6 pair of second generation adults. First generation egg masses were counted from June 21st - July 19th. Egg production dropped abruptly on July 10th and had ceased by July 26th. Therefore, all computations are based on July 10th as the end of the egg laying period. The 8 pair of beetles laid a total of 818 eggs during a 129 day period. This yields a fecundity rate of 6.4 eggs per day. Mating occurred many times throughout the egg laying period. Copulation was noted 39 times during the 129 day experiment, but since these recordings were made only during observation periods, it can be assumed that many matings went unobserved. The number of eggs produced by the second generation beetles was much less per day than for the first generation. The egg study jars were established with newly emerging beetles as they were observed copulating. The first day eggs were produced was considered to be the first day of the egg laying period and all computations are based on this day. Only 4 of the 6 pair of beetles laid eggs during the study period. The 4 pair of beetles produced 101 eggs over 38 days time. This yields a fecundity rate of 2.7 eggs per day. Copulation occurred

Riding is distinctly separate from copulation and the terms should not be confused. Close observation is necessary to determine if the male is actually affecting penetration or merely attempting it. Females will allow riding at this stage, but will not allow copulation.
more frequently in the first generation group. No explanation can be
given for the difference between the groups.

Egg laying occurred in an irregular pattern. Beetles laid eggs
every day for 1–4 days consecutively and then stopped laying for 1–2
days. This pattern occurred in both tests.

A number of *A. subplicata* adults were taken off of *S. interior* and
were fed *S. amygdaloides* for a number of weeks. Although the beetles
did feed on this species, they were not fond of it. This was apparent
since they consumed less and did not do as well as those fed on *S.
interior*. This intolerance could be due to the fact that they were
conditioned to feeding on *S. interior* as larvae and could not adjust
to the change as adults.

Field Work – Field observations for *A. subplicata* yielded no data
to confirm laboratory findings. Only 2 specimens were collected from
the study areas in the period between May 1, 1970 and mid-July 1971.
Both of these specimens were taken in 1970 on *S. interior*. Packard
(1887) and Wood (1917; 1918) both mention the periodic nature of many
of the *Altica* spp. Dr. E. U. Balsbaugh, Jr. indicated that moderately
large numbers of *A. subplicata* were present at sites C-111 (Fig. 36)
and D-100 in the fall seasons of 1967–68. The fact that only 2 indi-
viduals were taken in Brookings Co. in the last 1½ years, illustrates
once again the sporadic tendencies of this group.

9Personal communication.
Disomycha alternata

Laboratory - *Disomycha alternata* produce 1 generation per year and over-winter as adults. They pass through 3 larval stadia per generation and have a prepupal as well as a pupal stadium. Total cycle from egg through adult takes approximately 46 days. Research disclosed that *D. alternata* is host specific on *Salix interior* in eastern South Dakota. The beetle also seems to have specific habitat requirements as they were only found on *S. interior* located on sand or gravel, close to water. Wilson (1970) indicates that *S. interior* is the major pioneer tree species of flood plain areas. Thus, *Disomycha alternata* would probably be one of the pioneer insect species in this type of succession.

Description of Stadia:

Description of egg, based on examination of 10 eggs - nearly cylindrical, irregularly elliptical with both ends rounded; one end more truncate than other with widest diameter of egg closest to that end. Length 1.80 mm - 1.85 mm, mean 1.84 mm; diameter at greatest width 0.70 mm - 0.75 mm, mean 0.74 mm. Surface of egg minutely sculptured with fine reticulations; thickened lines of egg cuticle bounding elongate, hexagonal areas, other thinner lines of cuticle dividing these areas into smaller ones; hexagonal areas slightly convex. Color of eggs bright, shiny orange when freshly laid; turning to dull, powdery orange after a few hours (Fig. 29).

Description of first larval stadium - See discussion of larval morphology of *D. alternata*; note first stadium differences...
hatched larvae charcoal grey and fuzzy, slightly longer than egg upon hatching. After 3-4 days, larvae turn tannish-orange and remain this color until just prior to ecdysing. Approximately 12 hours before first molt, larvae turn black. Length of first instars 2.35 mm - 5.00 mm; head capsule width 0.500 mm - 0.575 mm (Fig. 39).

Description of second larval stadium - See discussion of larval morphology of D. alternata; note second stadium differences. Newly ecdysed larvae translucent, tannish-white, changing to greyish-black in ½-1 hour. Late instar larvae with pigmented areas brownish-black, general base color dull orange. Length of second instars 5.42 mm - 8.53 mm; head capsule width 0.75 mm - 0.90 mm (Fig. 39).

Description of third larval stadium - See discussion of larval morphology of D. alternata. Newly ecdysed larvae cream colored, turning to dull tannish-orange soon after molt. Length of third instars 8.39 mm - 11.65 mm; head capsule width 1.30 mm - 1.40 mm (Fig. 39).

Description of prepupae - The prepupal stage occurs within the pupal cell after the larvae burrow underground. Six of the larvae in the instar determination tests made their pupal cells against the side of the container and could be observed. After forming its pupal cell, the larvae contract to approximately 2/3rds full grown size and become somewhat barrel-shaped; they appear fat, with the head pulled well into the thorax. Setae on third stadium larvae are usually yellowish and transparent, with occasional black areas present. Nearly all the setae on a prepupa will show some black and 2/3rds of the setae will be ½ black.
Description of pupae - Pupae similar in size and general shape to adult. Color tannish-orange to bright orange. Homologies can be observed between many of the setae on pupae and third instar larvae. (Fig. 24, 26).

Description of adult - Length 6.50 mm - 8.50 mm; width 3.50 mm - 4.50 mm; body broadly oblong, moderately shining and pale, head with labrum, occiput and tubercles brown; pronotum with 2-5 spots; narrow sutural, median and submarginal vittae, some with median vitta incomplete; metasternum and tibia variably dark, tarsi dark. Head coarsely and rugosely punctate, frontal tubercles well marked; pale, with occiput, labrum and usually tubercles dark. Prothorax moderately convex, slightly to distinctly uneven with lateral callosities on either side in dorso-basal area, small median basal depression present; narrowing anteriorly with arcuate sides; alutaceous, finely and moderately punctate; pale, with 2 anterior well marked spots, lateral spots and median strip lighter, sometimes absent. Elytra with sides parallel, somewhat convex; humeri well marked with short intrahumeral sulcus; finely alutaceous, finely and densely punctate; vittae narrow, sutural and submarginal vittae only weakly uniting at apex, median vittae variable. Body venter coarsely and densely pubescent, pale with apex and tarsi dark. Aedeagus slightly curving, ventral lobe rounded with slight bump at apex; dorsal plate widening distally with rounded edges, center of edge drawn into pointed, finger-like projection (Fig. 33).
Biological History:

Eggs - laid in clusters of 15-43, with a mean of 34.0 per cluster. Female digs hole in sand and lays loose clusters of eggs in the hole (see discussion on adult D. alternata). The egg stage ranges from 7-11 days with a mean of 8.0 days. The larvae must dig their way to the surface after hatching. If the beetle is disturbed prior to or during egg laying, the normal pattern of laying is usually disrupted and the female will scatter her eggs around the inside of the container.

Larvae - The total number of days required from hatching to pupation was 15-27 days, with a mean of 17.0 days. There appeared to be some discrepancy in stadia length between the instar determination tests and the larvae reared in the type II containers. The instar determination tests indicate the following: first stadium 6-8 days, with a mean of 7 days; second stadium 5-6 days, with a mean of 5 days; third stadium 5-10 days, with a mean of 8 days; mean from hatching to pupation 20 days. These results appear to be slightly longer than the 17 day mean for the type II container reared beetles. Chittenden (1899) stated in regards to Disonycha xanthomelas, "It is more than probable . . . that the duration of the larval state varies considerably according to environment." This may explain the discrepancy found between the 2 studies, since they were not run concurrently.

Laboratory reared Disonycha alternata readily accepted Salix interior as a food source. The larval damage done to the willow was similar to that done by A. subplicata, the only difference being that only the first instar larvae of D. alternata typically skeletonize the leaves while the first and half of the second instar of A. subplicata
skeletonize. In *D. alternata* second instar larvae through adult feed from the lateral margin (Fig. 34, 35).

Prepupae, based on 8 individuals — larvae burrow into the sand, form pupal cells and become quiescent. Eight days later, in 1 case 9 days, the larvae ecdysed into pupae.

Pupae — Length of pupal period, inclusive of prepupal time, 19-26 days, with a mean of 23.0 days. Teneral adults remain underground for at least 1 day before emerging. Upon emergence, the adults are slightly lighter than normal color and their bodies are still quite soft (Fig. 33). Research seems to indicate that the larvae of *D. alternata* must burrow as a stimulus for pupation. During preparation of the instar determination series, a piece of sponge was placed in the bottom of each vial to hold moisture and keep the willow fresh. Later, when the expected date of pupation arrived, the larvae continued to feed. After 5 days had passed without any sign of pupation occurring, it was decided to place sand on the bottom of the containers. Within 3 hours after the sand was introduced, all 10 larvae in the vials containing sand had pupated. In the vials without sand, the larvae continued to feed for an additional 5 days, some attaining extreme size — up to 14.0 mm. These larvae became increasingly sluggish, stopped feeding and eventually ceased all movement. Two of these larvae did turn into prepupae, but all died. One exception occurred. This larva crawled through a small hole in the sponge into a larger interior cavity. After the larva was extracted from the sponge, it went through prepupal and pupal stages similar to the larvae in sand, and eventually emerged as an adult. All the larvae in
sand, with 2 exceptions, emerged as normal adults.

Adults - Adults used to start the colony were obtained on May 27, 1970, from *Salix interior* growing along the Missouri River, southwest of Elk Point, South Dakota. Adults were already laying eggs at the time of capture. Adults were also collected on May 9, 1971 at site A-100. These beetles were in copula at the time of capture, but were not yet laying eggs. The beetles from Elk Point were placed in type II rearing containers with solid lids and eggs were collected from these beetles for about 2 weeks. It soon became obvious that some form of disease had attacked the beetles. They became sluggish and their elytra showed greasy spots where the wings were clinging to the under-sides. After 2-3 days, the beetles began to emit a yellowish, pussy substance from the anus and within 5 days from this time any beetle showing symptoms died. Rearing procedures were checked with Dr. G. Sutter at the Northern Grains Insect Research Laboratory USDA Brookings, South Dakota and it was determined that the humidity in the containers was too high. Techniques were changed, but by that time 3/4ths of the colony had contracted the disease and the entire adult colony was lost. The colony was reestablished on June 20 using adults obtained from the A-100 collection site. No further major problems were encountered.

The total length of time from egg to adult ranged from 42-53 days, with a mean of 46.0 days. Greatest egg production was in June, with the total number decreasing in July. Copulation occurred throughout egg laying. Excessive mating apparently was not required for fertilization, as 1 female continued to lay fertile eggs for 10 days.
after the male escaped. Beetles were observed to lay eggs until shortly before death, 1 female laying 32 eggs 2 days before she died. Of the original overwintering adults, which numbered approximately 75, only 8 individuals were still living on August 1st. None of these were still laying eggs. *Disonycha alternata* adults began emerging in early July and emergence continued through August. Newly emerged adults did not mate or lay eggs for the duration of the summer and fall. The females refused all attempts to mate. This was confirmed with field observation.

It was observed that female *D. alternata* bury their eggs. The female digs a round hole, then turns until her abdomen is positioned over the opening. When the first egg is ready, the female lifts her body up and extends her abdomen forward. When the egg begins to protrude, she brings her abdomen slowly to the rear, laying the egg from front to rear directly under her abdomen. This process is repeated every 12-15 seconds until the entire clutch is laid. The female then turns around and immediately begins to cover the eggs. She braces herself with her hind legs, and working in a hand-over-hand motion, pulls the dirt underneath her until the area appears similar to the surrounding surface. The male was already copulating with the female before the eggs were completely covered.

Field Work - The field work on *D. alternata* proved to be very interesting. *Disonycha alternata* were found only in extremely restricted habitat, and in most cases, in large numbers. Five types of willow were examined as possible host species. These include; *Salix interior* Rowlee, *Salix amygdaloides* And., *Salix pentandra* L., *Salix*
lutea Nutt., and Salix eriocephala Michx. In all the areas sampled, D. alternata was found exclusively on S. interior. Eleven of the main collecting sites contained S. interior, however, only 3 of these sites supported populations of D. alternata. These sites, D-100, C-111 (Fig. 36), A-100 (Fig. 37), had 3 obvious factors in common; S. interior, course gravel to sand ground type, and some form of open water close by. Only 2 specimens were taken in areas other than the type just described throughout the entire collecting period. These were taken in the early spring and were considered incidental specimens. Specimens could be taken from the D-100 site at a rate of about 1-10/100 sweeps. This population did not seem to fluctuate very much between years. Site D-101 had 2 of the 3 factors present, S. interior and a gravel ground type, but no D. alternata were taken at this site. Site D-101 is approximately 1000 m from D-100. In 1970, Site A-100 had the heaviest infestation of beetles and larvae found. The numbers were so high that an average of 300 beetles could be taken in 100 sweeps. Even at this high infestation, the beetles never completely denuded the trees. By summer’s end, however, effects of the heavy feeding could be observed on the developing new leaves, as most seemed badly deformed. The following winter approximately ¼ of the trees died. An interesting example of habitat specificity is indicated by this site (Fig. 37). Salix interior is found on both sides of the Big Sioux River at this research area. The collecting site, A-100, is found on the north bank and has a gravel base, while the far bank has a soil base. The river is approximately 15 m wide at the site and collecting was done on both sides of the river. While the above
concentrations of both larvae and adult beetles were being collected from the gravel based north bank, the opposite soil based bank failed to yield any D. alternata.

Newly emerged beetles were observed in late August to determine if copulation or egg laying was occurring. Many beetles were observed feeding, and in a few cases males were observed 'riding', but no occurrences of actual copulation were observed. Observations were continued through September, at which time a representative sample of 20 females was collected and dissections were performed to determine the extent of egg development. At that time, no observable egg development had taken place. It can be assumed from this study that the beetles overwinter as adults.

As both Disonycha alternata and Altica subplicata appear to be species specific on Salix interior, it is conceivable that competition occurs between them. Dr. E. U. Balsbaugh, Jr.\textsuperscript{10} has observed on different occasions cohabitation of these species on willow and mentioned that at each encounter either one or the other was decidedly in the majority. Work could be done in this area to determine if competition does exist between these species.

Disonycha alternata and Altica subplicata can be considered minor economic species. The Sandbar willow, Salix interior, is a good erosion control plant. Its fibrous root system, spreading rapidly throughout the soil, does an extremely good job of stabilizing loose soil. These beetles could conceivably cause a great deal of trouble in erosion control areas.

\textsuperscript{10}Personal communication.
**SUMMARY**

*Disonycha alternata* and *Altica subplicata* are 2 flea beetles characteristically found feeding on *Salix interior*. Complete larval morphologies for these 2 species are presented here. *Altica subplicata* have 2 generations per year in South Dakota. The egg stage ranges from 6-9 days, with a mean of 7.0 days. Three larval stadia are present, ranging from 15-17 days, with a mean of 16.5 days. The pupal stage ranges from 10-13 days, with a mean of 12.0 days. The total egg to adult cycle ranges from 31-37 days, with a mean of 34.0 days. No field data is available for this species. *Disonycha alternata* have 1 generation per year and overwinter as adults. The egg stage ranges from 7-11 days, with a mean of 8.0 days. Three larval stadia are present, ranging from 15-27 days, with a mean of 17.0 days. The pupal stage ranges from 19-26 days, with a mean of 23.0 days. The total egg to adult cycle ranges from 42-53 days, with a mean of 46.0 days. *Disonycha alternata* is host specific on *Salix interior* and extremely habitat specific.
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ABBREVIATIONS USED ON FIGURES

Ab - abdomen
Ant - antenna
AO - anal opening
AS - anal shield
Cd - cardo
c1 - claw
Cly - clypeus
Cx - coxa
EpM - epimeron
Eps - epicranial suture
EpS - episternum
F - frons
Fe - femur
FeC - frontal endocarina
FM - foramen magnum
ga - galia
Hd - head
la - lacina
Lb - labrum
Lp - labial palpus
Md - mandible
Ms - mesothorax
MsL - mesothoracic leg
MsW - mesothoracic wing
Mt - metathorax
MtL - metathoracic leg
MtW - metathoracic wing
Mx - maxillary palpus
Oc - ocellus
P - pleural area
Pf - palpifer
Pm = prementum (prelabium)
Pt - prothorax
PtL - prothoracic leg
Ptm - postmentum (postlabium)
PtS - prothoracic shield
pu - pulvillus
S - sternal area
sp - spiracle
St - stipes
T - tergal area
T-T - tibio-tarsus
V - vertex

+ - + - + - Division line between body areas

* - Tactile papilla of galia
Fig. 6. - *Altica subplicata* larvae, dorsal view.

Fig. 7. - *Altica subplicata* larvae, lateral view.

Fig. 8. - *Altica subplicata* larvae, ventral view.
Fig. 9. - *Disonycha alternata* larvae, dorsal view.

Fig. 10. - *Disonycha alternata* larvae, lateral view.

Fig. 11. - *Disonycha alternata* larvae, ventral view.
Fig. 12. - *Disonycha alternata* larvae, anterior view of head.

Fig. 13. - *Altica subplicata* larvae, anterior view of head.

Fig. 14. - *Disonycha alternata* larvae, posterior view of head.

Fig. 15. - *Altica subplicata* larvae, posterior view of head.
Fig. 16. - *Altica subplicata* larvae, left mandible, ental aspect.

Fig. 17. - *Altica subplicata* larvae, left metathoracic leg.

Fig. 18. - *Altica subplicata* larvae, right mandible, ental aspect.

Fig. 19. - *Disonycha alternata* larvae, right maxilla, ectal aspect.

Fig. 20. - *Altica subplicata* larvae, right maxilla, ectal aspect.

Fig. 21. - *Disonycha alternata* larvae, right mandible, ental aspect.

Fig. 22. - *Disonycha alternata* larvae, left maxilla, ental aspect.

Fig. 23. - *Disonycha alternata* larvae, left metathoracic leg.
Fig. 24. - *Disonycha alternata* pupa, ventral view.

Fig. 25. - *Altica subplicata* pupa, ventral view.

Fig. 26. - *Disonycha alternata* pupa, dorsal view.

Fig. 27. - *Altica subplicata* pupa, dorsal view.
Fig. 28. - *Altica subplicata*, hatched eggs and first instar larva.

Fig. 29. - *Disonycha alternata*, eggs and first instar larvae.
Fig. 30. - *Altica subplicata* larvae, third instar.

Fig. 31. - *Disonycha alternata* larvae, third instar.
Fig. 32. - *Altica subplicata* adult.  
Actual size. 

Fig. 33. - *Disorycha alternata* adult.  
Actual size.
Fig. 34. - *Salix interior* leaf showing larval feeding damage and early second stadia. Similar for both *Disonycha alternata* and *Altica subplicata*.

Fig. 35. - *Salix interior* leaves showing feeding damage of the stadium larvae and adult beetles. Similar for both *Disonycha alternata* and *Altica subplicata*. 
Fig. 36. - Collection site C-111 at old gravel pit. Showing _Salix interior_ growing on gravel banks near water.

Fig. 37. - Collection site A-100, on proximal shore along Big River. _Salix interior_ growing on both sides of river. _Dicyochea alternata_ only found on those willow grown over gravel.
Fig. 38. - Temperature range for rearing season, 1970.

⊙ Temperature, type I containers

⊙ Temperature, type II containers
Fig. 39 - Range of larval head capsule width vs larval body:

- **Altica subplicata**
- **Disonlycha alternata**