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Cuterebra (Diptera: Cuterebridae) of Utah and the Neighboring States

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CUTEREBRA (DIPTERA: CUTEREBRIDAE) OF UTAH AND THE NEIGHBORING STATES

by

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INTRODUCTION

Cuterebra are robust flies, which in flight resemble large black bees. Little is known about the bionomics of most of the species included in this genus. Nearly all members of this group parasitize rodents and lagomorphs. Some species have a wide host range, others seem to be specific or semi-specific to a single host. Accidental parasitism of animals other than specific host animals does occur. In such cases the larvae or the host usually die before the larvae can mature. There is a wide variation in the effect of of the parasite on its host. If the parsite is found in a natural host, the ability of the host to tolerate the parasite is much greater. In chipmunks one to three parasites have no apparent effect but with four to nine parasites in one animal, there is a loss of weight and a decrease in activity. Occasionally death results from parasitism by Cuterebra.

A valid key to the species of this genus does not exist. It is the purpose of this paper to establish a valid key for the described species of Cuterebra found in Utah and the neighboring states and to furnish descriptions of these species, which in conjunction with the key will aid the reader in identification of Cuterebra specimens. Whenever possible the host or hosts associated with each species will be listed.

Within the genus Cuterebra there are several species complexes. As used here, complexes are supposedly intraspecific groups which have

several major characteristics in common but differ on a few minor points. Only more detailed studies on the members of these complexes will indicate the extent of intraspecific variation and the delimitation of a true species.

REVIEW OF LITERATURE

Classification

The genus Cuterebra was created by Clark (1815). In the same year Leach created the family Oestridae (Sabrosky, 1961). The genus Cuterebra was placed in this family until Austen (1895) created the family Cuterebridae.

Bennett (1955) reported that in 1934 Townsend and Curran independently developed two methods of classification for this group. Curran's classification (1934), which includes the genus Cuterebra and three other genera in the family Cuterebridae, is accepted by C. W. Sabrosky and will be the classification used by the author. Dr. Sabrosky is working on the taxonomy of higher flies and problems of zoological nomenclature at the U. S. Department of Agriculture, Insect Identification and Research Division, in Washington, D. C. At present he and Gordon F. Bennett of Toronto, Canada are investigating the taxonomy of the adults and larvae of the genus Cuterebra.

Identification

Swenk (1905) of the University of Nebraska, published a key, "The North American Species of Cuterebra." This key deals, for the most part, with single color characteristics. From the author's study of the fontinella complex these characteristics vary, thus limiting the usefulness of this key. Also, Swenk's key is obsolete because of the addition of new species since

1905 and because some of the species in the key have been placed in synonomy (Dalmat, 1943). At present the only authority on Cuterebra identification is C. W. Sabrosky of the National Museum in Washington, D. C.

Identification of the larvae can be done only to genus at present.

Rearing of Immature Stages

Fertile Cuterebra latifron eggs require 9-24 days to hatch and larval longevity is 6-7 days. Larvae are fully active at the time of hatching, exhibit positive phototaxis, thermotaxis, and geotaxis and are positively attracted to the human finger (Radovsky and Catts, 1960).

In order to be relatively sure of obtaining adult flies from larvae-infested rodents, the larvae should be "full fed" (Clark, 1815). Only with mature larvae can one be reasonably sure of obtaining adult Cuterebra.

Ryckman (1953) described procedures for rearing Cuterebra latifrons Coquillett from a dusky-footed wood rat in California and Dalmat (1943) relates his experiences in rearing Cuterebra peromysci Dalmat from northern white-footed mice near Ames, Iowa. In the only detailed study of Cuterebra in Utah, Ignoffo (1960) reared Cuterebra jellisoni Curran from the desert jack rabbit. In the study by Ignoffo it was determined that C. jellisoni females were present in the field from May 10 to June 20, and Cuterebra larvae were found associated with jack rabbits from May 18 to August 16. Only 32 adult Cuterebra emerged from the 136 pupae collected during this experiment.

METHODS AND MATERIALS

Collection of Data

The Museum of Natural History in New York City, New York, and the U. S. National Museum, Washington, D. C., were visited in June of 1961 for the purpose of studying the Cuterebra specimens in the insect collections. Notes were taken on descriptions and on locations where type specimens were collected. The taxonomy of the group was discussed with Dr. C. W. Sabrosky of the National Museum. Dr. Sabrosky has been interested in the group for many years.

The University of Utah and Brigham Young University were visited and the species of Cuterebra in their collections were studied. Specimens from the collections of the University of Idaho, Colorado State University, Arizona State University, and University of Arizona were obtained on a loan basis. These specimens were studied, identified, and returned after noting the species which were present.

As many of the original descriptions as possible were obtained. Most of those which were not obtainable in the Utah State University Library were acquired through the library loan system or through the purchase of microfilm.

Techniques for Collecting and Rearing Cuterebra

During the summers of 1960-61 five field collecting trips were conducted to an area of Cuterebra infestation south of Manila, Utah. The animals infested were Eutamias quadrivittatus, the western chipmunk. The area in which the infested animals were found was mountainous and chipmunks were trapped between elevations of 5,000 and 8,000 feet. The major trees found in the area were lodge pole pine, yellow pine, aspen, and some fir. Approximately 50 per cent of the animals caught were parasitized by Cuterebra. Cuterebra larvae were found to be present in the host from late July to mid-September. The infested chipmunks were trapped alive in 3 x 3 x 10 inch National Live Traps, and were placed in 1 x 1 x 1 foot specially constructed cages (Figure 1) which had floors of 1/2 inch mesh screen. Floors made of smaller mesh screen would not allow the larvae to drop free from the cage. Chipmunks would usually bite or eat the larvae within their reach. These cages were made inexpensively from 1 x 2 inch lumber and 1/2 inch mesh screen. Each cage was equipped with a nest box, a watering bottle and a feeding dish (Figure 1). The nest box did not contain nesting material because this would have restricted the mature larva from falling through the screen floor if it left the animal in the nesting box.

The cages were placed over a box containing 3 to 4 inches of damp sand for the pupation of the larvae. After a larva left the host an interval of at least 24 hours was allowed before searching for the pupa in the sand. This interval enabled the larva to form a hardened puparium. The pupa was then

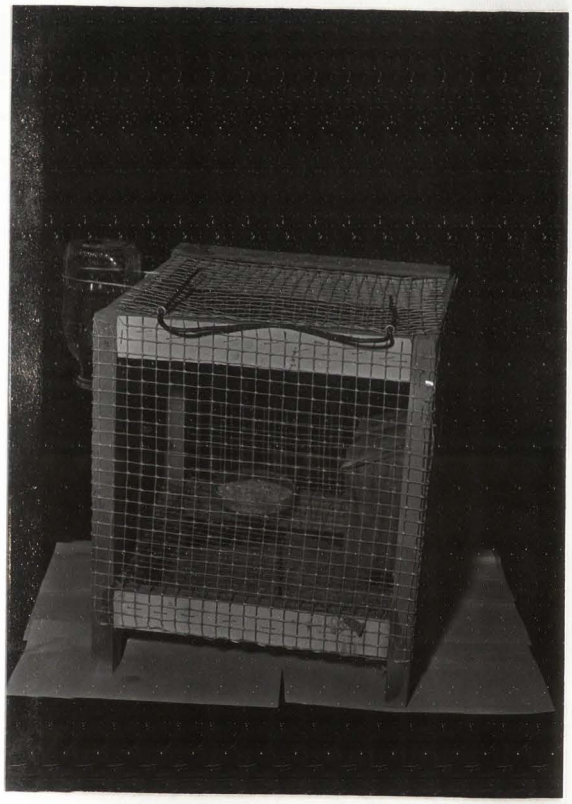

Figure 1. Cage and equipment used for infested chipmunks.

transferred to a container of dry sand for storage or cold treatment.

The containers used by the author were 8 ounce jars half filled with dry sand. A label was placed on each jar and such data as jar number, date of emergence from host, days spent at a particular temperature, and emergence date of the adult fly were kept on these labels.

While the puparia were in cold treatment the sand in which they were buried was dry. However, upon removal to temperatures where emergence of adult flies was desired the sand was moistened. The moisture was necessary for complete normal development of adult fly wing characteristics. The puparia were buried in the sand so that the opercula were level with the sand surface or less than 1/8 inch below the surface. In this way the flies had little trouble leaving the puparia, whereas those puparia buried deep in the damp sand did not open to pressure exerted by the ptilinium. A piece of crumpled tissue paper, about 2 inches in diameter was placed in each jar. This enabled the fly to crawl free of the sand, clean itself, inflate its wings and retract the ptilinium without small grains of sand hindering the last two processes.

The tops of the jars were covered by gauze held in place with a rubber band. The gauze trapped the imago in the jar after it emerged. All attempts to induce mating of adult Cuterebra under laboratory conditions were unsuccessful.

DESCRIPTION OF THE GENUS

Cuterebra Clark, 1815

Cuterebra Clark, 1815, An essay on the bots of horses and other animals. p. 70

Bogeria Austen, 1895, Ann. Mag. Nat. Hist. 15:391

Pseudobogeria Bau, 1929, Zentr. Bakt. Paresitenk. 77:543

Description by author: Head large, broader than long, prominent oral cleft anterior posterior ventrally, ventral facial regions covered with fine yellowish or black hairs. Mouth parts present, usually retracted; eyes large, widely separated dorsally in both sexes, though less in males than females, color red to deep brown; antennae three segmented, arising from prominent facial depression; arista arising from dorsal surface distal segment, distal one-third of arista with hairs dorsal and ventral, proximal two-thirds with hairs dorsal; three ocelli present dorsally. Thorax broad as long, covered dorsally by thinly set hairs, pleura covered with dense pile; scutellum prominent. Abdomen broad as long, covered with fine hairs; tergites large, almost meeting ventrally; sternites small deep set in ventral groove. Legs medium build, medium length; tarsae broad, two-thirds as long as tibia, empodium short, spike like; pulvillae large. Wings brown; calypteres large. Body large, robust. Length, 15-24 mm.

Note: Clark's original description is inadequate and does not indicate the differences between sexes.

KEY TO THE SPECIES OF CUTEREBRA FOUND IN UTAH AND THE NEIGHBORING STATES

1. Fourth abdominal segment clothed with short yellow hairs 2

1'. Fourth abdominal segment without short yellow hairs 3

2(1). Thorax with black hairs dorsally . . . . fontinella (complex)

2'. Thorax with thinly set white hairs dorsally except scutellum which is black with black hairs . . . . . grisea

3(1'). Thoracic pleura black, dark brown, or black with white pile below wing base 4

3'. Thoracic pleura with dense white pile 7

4(3). Thoracic pleura dark brown with black to dark brown hair. Abdomen without pollen[a] like scales and appearing a glistening brown . . tenebrosa

4'. Thoracic pleura clothed with black pile, abdomen metallic blue-black with or without white pollinose[b] areas laterally 5

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[a]Pollen is defined as a dusty or pruinose surface covering easily rubbed off.

[b]Pollinose is defined as a covering with a loose, mealy, often yellow dust, like the pollen of flowers.

5(4'). Thoracic pleura with light dust-like pollen beneath black pile, ventral half anterior calypter rimmed with white hairs, abdomen with white pollinose areas laterally . . . . . approximata

5'. Thoracic pleura with white pile below wing base, both calypters rimmed with white or rimmed with brown hairs 6

6(5). Thoracic pleura with white tuft of hairs just below alulae of wing, ventral margins of calypters rimmed with white hairs . . . . . similis

6'. Hind margins of mosepleura fringed with white pile, calypters rimmed with brown hairs (see description for male characteristics . . . . . atrox

7(3'). White supra alar tuft absent, abdomen shining black without pollen . . . . . polita

7'. White supra alar tuft present, abdomen entirely white pollinose 8

8(7'). Entire body covered with white dust-like pollen, abdominal spiracles conspicuously rimmed with short black hairs . . . . . ruficrus

8'. Entire body not covered with white dust-like pollen, abdominal spiracles not rimmed with black hairs 9

9(8'). White supra alar tuft extending back entirely rimming scutellum with dense white pile . . . . . princeps

9'. Supra alar tuft present but not rimming scutellum 10

10(9'). Prothoracic femora with white hairs ventrally, entire abdomen white pollinose interspersed with shiny blue-black dots . . . . . jellisoni

10'. Prothoracic femora with or without white tuft, abdomen brown pollinose laterally 11

11(10'). Prothoracic femora without white tuft in case of male but with a white tuft near tip of femora in female, abdomen shining steel-blue, all abdominal segments brown pollinose laterally, interspersed with steel-blue dots . . . . . lepivora

11'. Prothoracic femora always without white tuft, abdomen with white or brown pollen laterally on first two or three segments 12

12(11'). Pollinosity of abdomen when present restricted to posterior margins of first and second abdominal segments and appearing as white lines . . . . . nitida

12'. First three abdominal segments white or brown pollinose laterally, these never extending across abdomen dorsally, pollinose areas interspersed with shining blue-black dots . . *americana* (complex)

DESCRIPTIONS OF THE SPECIES OF CUTEREBRA FOUND IN UTAH AND THE NEIGHBORING STATES

Cuterebra americana Fabricius, 1775

Musca americana Fabricius, 1775, Systema Entomologiae. p. 774

Cuterebra cauterium Clark, 1815, An Essay on the Bots of Horses. p. 70

Cuterebra americana Brauer, 1863, Monographie der Oestriden. p. 242

Description by E. E. Austen (1933). Male: Head black, occiput dark olive-grey pollinose, posterior orbits and hind border of jowls (basioccipital region) whitish silvery or olive-buff pollinose; in contact with inner margin of each eye four small triangular or bluntly triangular, whitish or silvery, pollinose spots; second spot counting from above on level with second segment of antenna, and with a small but otherwise similar spot in contact with frontal groove; lower extremity of latter on each side bordered by a small, pale neutral grey, pollinose patch; antennary pit pale neutral grey pollinose, with sharp concave septum; first two segments of antennae russet, sparsely clothed with minute, glistening, ochreous hairs, third segment mummy-brown; occiput clothed with black hair, hind margin of basioccipital region clothed with cinnamon-brown hair; front (frons) and sides of face clothed with short black hair, lower part of face, adjacent to margins of narrow clypeus, clothed with whitish hair.

Thorax: pleurae with two small, dark shining spots, devoid of hair and pollinose covering, below tuft of black hair mentioned in diagnosis above; hair on dorsum, including scutellum, very short and appressed, except on humeral and postalar calli, where it is longer; sternum clothed with black hair.

Abdomen: dorsum clothed with very short black hair, distal extremity with longer black hair; lateral extremities of fourth (visible) tergite only with traces of smoke-grey pollinose covering; venter blackish purple, clothed, like lateral extremities of tergites, with fairly long black hair. Wings sepia-coloured. Squamae mummy-brown, with cinnamon-brown fringes. Halteres sepia-coloured.

Legs: Femora and tibiae blackish-brown, tarsi black; legs clothed with black hair, extensor surfaces of tibiae with moderately

developed fringes; base of anterior surfaces of middle and hind femora, base of extensor surfaces of front and middle tibiae, and proximal two-thirds of extensor surfaces of hind tibiae pale smoke-grey pollinose; claws black; pulvilli mummy-brown. Length, 21.75 mm.

Female: Same as above

Type located: Unknown

Collected: Unknown

Host: Unknown

Cuterebra approximata Walker, 1866

Cuterebra approximata Walker, 1866, Nat. in Vancouver Is. and B. C. (by J. K. Lord) 2:338-339

Female: Black, head minutely punctured above, slightly rugulose towards the mouth; vertex with a slender, smooth furrowed line. Thorax slightly covered with dark cinereous tomentum. Abdomen dark blue. Wings and alulae blackish; veins black. Length of body, 10 lines; of wings, 18 lines.

Supplementary description: Head entirely shining black, except with or without three white pollinose spots contiguous with anterior margin of each eye, also white pollinose spots dorsally each side antennal depression; antennae three segmented, black, distal one-third arista and hairs yellow, proximal two-thirds black. Thorax wholly black, entirely covered by black hairs. Pleura with white dust-like pollen beneath black hairs. Abdomen shining steel-blue first three segments with areas white pollinose laterally. Legs black except proximal one-third tibia and femur with white pollinose areas. Wings and calypteres brown, except lower half of anterior calypter with white fringe. Length, 20-22 mm.

Male: Same as above

Type located: British Museum

Collected: British Columbia, Canada

Host: Peromyscus sp.; Neotoma sp.

Cuterebra atrox Clark, 1848

Cuterebra atrox Clark, 1848, Addenda to an essay on the bots of horses and other animals. p. 5

Description by E. E. Austen (1933). Head black and clothed with black hair, sides of front and forward linear extension of ocellar triangle often more or less russet or cinnamon-brown; whitish, light buff or light ochraceous-buff, pollinose marks (some of which may be indistinguishable in individual speciments, according to condition), when complete, consisting of five spots, triangles or linear marks in contact with inner and lower margins of each eye, a tiny additional fleck on each side near frontal groove, on a level with second spot of former series counting from above, and an edging to each lower extremity of frontal groove; lowest mark but one, when complete, elongate and curved, extending nearly to level of lower extremity of frontal groove; mark in contact with lower margin of eye oblong or curved (crescentic), conspicuous and characteristic; posterior orbits narrowly whitish or light buff pollinose; antennary pit smoke-grey pollinose, with small, concave septum; antennae blackish brown, first two segments in male often russet, and clothed at least in part, with minute, glistening, ochraceous-buff hairs, these segments otherwise clothed with blackish-brown hairs; arista blackish-brown at base, then reddish-brown, its attenuate portion, like hairs clothing it, pale pinkish buff.

Thorax: dorsum, including scutellum, uniformly clothed with appressed black hair, except that male has an elongate patch of Naples-yellow hair above base of wing on each side; pleural spot or patch of black hair in male showing individual variation in size, and sometimes so large as anteriorly to be almost or actually in contact with black hair on dorsum; pectus in both sexes clothed with black hair, which in male sometimes sends upwards a narrow offshoot behind mesopleura.

Abdomen: dorsum clothed with short, appressed black hair, that on last (visible) tergite, and on lateral (deflexed) extremities of preceding tergites longer; venter bluish-black, clothed with black hair; in some specimens olive-buff pollinose covering of sides of second and third

(visible) tergites extending a narrow or even linear, sometimes interrupted, transverse bands across anterior margins of these tergites, such bands in places encroaching on hind margins of preceding tergites.
Wings, squamae, and knobs of halteres mummy-brown, stalks of halteres paler (tawny-olive).
Legs black, clothed with black hair, tibiae with broad fringes on extensor surfaces; femora sometimes with more or less pronounced chestnut-brown twinge, their anterior surfaces near base, at least in case of middle and hind pairs, with an oval or elongate, silvery-white, pollinose patch; all tibiae, at any rate on extensor surfaces, also silvery-white pollinose at base; claws chestnut-brown at base, their tips black; pulvilli cinnamon-buff.

Supplementary description: Pleura of female black, except hind margins of mesopleura which are fringed with white pile. Lateral pollinosity of abdomen in female greatly reduced and restricted to ventral surfaces of abdominal tergites.

Type located: Hope collection, Oxford Museum, England

Collected: Mexico

Host: Unknown

Cuterebra fontinella Clark, 1827

Cuterebra fontinella Clark, 1827, Trans. Linn. Soc. 15:410-411

Translation of Clark's latin description: General description:
Thorax black, pleura white, abdomen violet, the extreme segments white with black dots.
Male: The Cuterebra of the rabbit is small; head dark, sub-cylindric, not as deep as wide, brow dark above, around the eyes bright, below whitish covered with white hair, on each gena a raised dark spot. Eyes dark black. Thorax black dorsally, pleura covered with thick white hair, marked with three black spots on each side. Wings dark with many wrinkles, longer than abdomen; squamae large, erect, and scale-like; breathing apparatus covered with membrane at the borders, this slopes downward. Abdomen short, dark, from above reflecting like a violet mirror, the two extreme segments with whitish hair

and whitish rough surface which has various raised dark spots which are hairless. Anus with claspers each side. Feet dark

Supplementary description: Thoracic pleura with or without black tuft midway between wing base and eye margin, male with but female with or without supra alar white tuft. Length, 16-18 mm.

Female: Same as above

Type located: Unknown

Collected: Illinois

Host: Cottontail rabbit, chipmunk

Cuterebra grisea Coquillett, 1904

Cuterebra grisea Coquillett, 1904, Can. Ent. 36:11-12

Female: Near fontinella, but the hairs of the mesonotum are whitish; also near scutellaris, but the last abdominal segment is largely opaque, gray pruinose. Black, the abdomen and legs dark reddish brown; front at vertex one and one-half times as wide as either eye, its hairs black and with several yellow ones on the lower portion, two gray pruinose spots along each eye and one on either side of insertion of antennae; face and cheeks densely gray pruinose, the upper portion of sides of face broadly, a triangular spot on either side of lower part of facial cavity, a small spot at lower end of each eye and one nearly midway between it and the oral margin, also two streaks along the anterior portion of the latter, polished, margins and lower portion of facial depression, except in the middle, also polished, hairs of face and cheeks whitish, those on upper portion of face chiefly black; (antennae wanting); thorax gray pruinose, its hairs whitish, those of the hypopleura, middle of breast and scutellum black, a row of three polished spots near the lower front corner of the pleura; abdomen polished, the last segment and venter of the last three gray pruinose, several spots and the hind margin of the last segment polished, hairs of abdomen black, those of the last segment and venter of the last three chiefly yellow; legs polished, an elongate, whitish pruinose spot on front side of middle femora, hairs black, those on inner side of apical half of front tibiae golden yellow, on inner side of

other tibiae chiefly white; wings brown, veins yellow, calypteres dark brown.
Length, 15 mm.

Male: Same as above

Type located: U. S. National Museum, Washington, D. C.

Collected: Fort Simpson, B. C., Canada

Host: Peromyscus sp.; Eutamias sp.

Cuterebra jellisoni Curran, 1942

Cuterebra jellisoni Curran, 1942, Bull. Mus. Nat. Hist. 80:78

Black, with cinereous pollen, the abdomen with metallic blue or bluish green reflections in some lights; intermediate abdominal segments almost all cinereous pollinose; scutellum with black hair only.
Male: Head black, densely cinereous pollinose, the front almost bare but with two orbital pollinose spots below, the lower one sometimes connected with the spot above the outer base of the antennae. On the face there are three bare spots, a large broad transverse one above, a small one below the eye and one half-way between this and the oral margin. Pile white, black on the front but mostly yellowish on the anterior half. Front not three times as wide as the ocellar triangle, strongly widening anteriorly. Antennae blackish to brownish red, the arista yellowish and plumose on the apical half, blackish and pectinate on the basal half. The carina separating the sides of the antennal depressions is high and sometimes little concave in profile on the lower half, but this varies in the specimens before me.
Thorax black, rather thinly cinereous pollinose, the pleura with dense white hair, the dorsum with appressed black hair except for a white lateral patch above the base of the wings and sometimes a few white hairs at the outer end of the suture. There are two bare blackish spots near the middle on the anterior half of the pleura and a tuft of black hairs above. The scutellum is black haired, at most three or four whitish hairs being present on each side near the apex. Legs black, and with black hair, the anterior femora densely short white haired posteriorly, and there are some white hairs basally on the middle femora; all the femora are silvery white pollinose below on about the basal half. Wings light brownish, the hair on the squamae

all white. Abdomen metallic steel blue or with greenish reflection, the base black, the intermediate segments densely cinereous pollinose, with some large irregularly placed shining spots, with a narrow median bare vitta and the narrow apices of the segments incompletely shining; the apical segment is about half shining above, the base being widely pollinose laterally and narrowly so in the middle. The amount of pollen on the apical segment varies, and when the large bare spots are confluent with the posterior shining portions the segment may be more than half shining. The sternites are black haired, while the inner edges of the tergites bear white hair except at the base. Length, 19-21 mm.

Female: Same as above

Types located: U. S. National Museum, Washington, D. C. and

Museum of Natural History, New York City, N. Y.

Collected: Paisley, Oregon

Host: Jack rabbit

Cuterebra lepivora Coquillett, 1898

Cuterebra lepivora Coquillett, 1898. Can. Ent. 30:9-10

Male: Head black, destitute of light-coloured pollen, front at narrowest point three times as wide as distance between the two posterior ocelli, subopaque, an opaque streak of brownish pollen on each lower corner contiguous to the eyes, hairs of front black, several above the antennae yellow; antennae black, apical two-thirds of the arista and its hairs yellow; face and cheeks sub-shining, rugose, an opaque spot on each side of the face contiguous to the eyes, the hairs and those of the occiput pale yellow. Thorax black, subopaque, hairs of the dorsum black, a cluster above each wing and those of the pleura yellowish-white, a cluster of black hairs midway between the wing and the head; pleura opaque, two polished black spots above each front coxa; scutellum black, its hairs also black. Abdomen shining steel-blue, the sides of the first three segments partly brown pollinose, on the second segment extending nearly half-way to the middle of the dorsum, leaving numerous spots uncovered and polished, hairs of the abdomen, including those of the venter black. Legs black, the femora toward their bases whitish pollinose, the hairs wholly black. Wings and calypters brown. Length, 19 mm.

Female: Same as the male, with these exceptions: Front nine times as wide as distance between the two posterior ocelli; face and cheeks smooth, opaque brownish pollinose, the upper part of the face and two spots each side, one of which is contiguous to the eye, the other nearly midway between it and the mouth, polished black. Hairs of venter of abdomen largely yellowish-white. Front femora each bearing a cluster of whitish hairs on the under side a short distance before the tip. Length, 22 mm.

Type located: U. S. National Museum, Washington, D. C.

Collected: (Male) Corbett, Wyoming (Female) Anaheim, California

Host: Cottontail rabbit

Cuterebra nitida Coquillett, 1898

Cuterebra nitida Coquillett, 1898, Can. Ent. 30:10

Male: Differs from the above description of the male of lepivora only as follows: Front subshining, two opaque spots of brownish pollen each side contiguous to the eyes; no yellow hairs above the antennae. Abdomen wholly polished, destitute of pollen. Front tibiae at base of outer side white pollinose. Length, 19 mm.

Supplementary description: Thorax with sharp line of demarcation between black dorsum and white pleura at wing base. Abdomen not wholly polished but having narrow band of white pollen on posterior margins of first and second abdominal segments. Tibia with especially prominent pollinose area proximally. Anterior calypter with white fringe.

Female: Same as above

Type located: U. S. National Museum, Washington, D. C.

Collected: Los Angeles County, California

Host: Unknown

Cuterebra polita Coquillett, 1898

Cuterebra polita Coquillett, 1898, Can. Ent. 30:10

New description of Holotype: Female: Face dark brown except narrow band of white pollen along anterior margins of eyes. Antennae three segmented short, anterior two-thirds of arista yellow, hairs of face brown. Thorax black, hairs dorsally and ventrally black. Pleura with longitudinal band of white pile, this area without black tuft of hairs midway between wing base and lateral margin of the eye, supra alar white tufts also absent. Abdomen without pollen, wholly polished biolet-black. Legs brown with black hairs, tibia and femur with pollinose areas proximally. Length, 16 mm.

Male: Same as above

Type located: U. S. National Museum, Washington, D. C.

Collected: National Park, Wyoming

Host: Cottontail rabbit

Cuterebra princeps Austen, 1895

Bogeria (Cuterebra) princeps Austen, 1895, Ann. and Mag. Nat. Hist. ser. 6, 15:377-396

Cuterebra lepusculi Townsend, 1897, Psyche 8:8

Cuterebra albifrons Swenk, 1905, New York Entomol. Soc. J. 13:182-183

Male: General colour of thorax brownish grey, abdomen silvery grey; ground-colour reddish brown, concealed by greyish dust;

thorax and abdomen nearly bare above; pleurae clothed with thick white pile, which extends in a stripe above the base of the scutellum. Head almost precisely the same width as the thorax, the latter appearing slightly broader at the base of the wings, owing to the pilosity of the pleurae; front thinly clothed below with short appressed yellowish-white hairs, and above and on the vertex with short erect blackish hairs, and forming a rounded projection in front of the eyes when the insect is viewed from above; a narrow median shining black triangle extending forwards from the anterior ocellus to a distance of 1 1/2 millium.; a strongly marked ridge surrounding the antennary pit, except below, and bounded by the vertical semi-circular fissura frontalis; antennary pit contracted below into a narrow flattened median ridge extending to the oral cleft; septum separating the antennae well marked; antennae blackish brown, second joint reddish brown; arista bright reddish brown; first joint and extreme base of the second black; a shining dark brown semi-lunar spot above the base of each antenna, while, on a slightly lower level, a transversely elongated shining spot of a similar colour extends upwards and inwards from the margin of each eye; above each of the latter spots a small silvery-white triangle, resting on the margin of the eye: face and cheeks silvery white; face covered with somewhat coarse closely-set punctures, which become smaller below and are absent on the cheeks below the eyes; face and cheeks clothed with silvery-white pile, which is very sparse on the former, but thicker on the latter, and partially conceals the oral cleft; a curved shining black mark on each side of the antennary pit below, continued backwards as a narrow incised line on each side of the contracted portion, and ending in a small triangular shining spot on each side of the commencement of the wider portion of the oral cleft; between each of these spots and the eye, and nearer the latter, a conspicuous, sharply defined, and somewhat rounder shining spot, while in the same straight line and close to the orbit lies a much smaller and less distinct fleck, above which and halfway between it and the transverse shining spot already mentioned is a similar mark; the extremity of the vertical are of the fissura frontalis on each side dull black; occiput clothed with silvery-white pile; occipital orbits silvery white.

Thorax and scutellum thinly clothed above with short black pile, which becomes more conspicuous and forms a distinct longitudinal stripe above the thick white pile of the pleurae; pectus also clothed with thick white pile; posterior border of the scutellum thinly clothed beneath with whitish pile, which projects beyond the margin, and so gives the scutellum a whitish rim.

Abdomen coarsely granular above; posterior border of third, fourth, and fifth segments and that of the second on the sides narrowly shining black; upper surface thinly clothed with short black hairs; basal angles in the typical specimen clothed with longer silvery-white pile,

in front of which is a little black pile, while the basal angles are connected by a semilunar band of silvery-white pile, which conceals the hind margin of the second segment, and in the median line projects on to the third segment, which is clothed in the centre behind this projection with brownish pile, in the other specimen the longer pile on the second segment is for the most part brownish, a little paler and thinner in the middle of the hind margin, while there is more black pile on the sides of the segment in front; ventral groove thickly clothed with whitish pile, except in the median line; sides of the segments below thinly clothed with short silvery pile; genital ring a broad quadrangular plate.

Legs: coxae shining black, pollinose, clothed with whitish pile, the posterior pair also with black hairs; femora reddish brown, pollinose, apices black, extreme tips shining, clothed above and below with whitish pile, while the second and third also bear a certain number of black hairs on the inner side at the base and above; tibiae and tarsi black, greyish pollinose, the former thinly clothed, the latter fringed at the sides with black hairs; claws black, sometimes reddish brown in the middle.

Wings uniformly light brown; alulae and squamae also brown, the margin of the latter paler and fringed with very short silvery pile; alulae very conspicuous when the wings are at rest, directed upwards, and embracing the scutellum on each side. Length, 20 1/2-21 1/2 mm.

Female: Same as above

Type located: British Museum

Collected: Medano Blanco, Mexico (Gulf of California)

Host: Jack rabbit, cottontail rabbit

Cuterebra ruficrus Austen, 1933

Cuterebra ruficrus Austen, 1933, Zool. Soc. London Proc. 2:173

New description of Holotype: Female: Face lightly white pollinose except shiny brown stripe each side from eye margin to dorsal margin of antennal depression, lower half of face with white hairs, also shiny brown spot on each genae below each eye. Thorax lightly white pollinose with short white

pile laterally and ventrally. Abdomen entirely lightly white pollinose except spiracles of thorax conspicuously ringed with short black hairs, also posterior margins of abdominal segment without pollen and shiny brown. Wings brown, calypters brown, calypters rimmed with white hairs. Proximal portion of femur appearing light brown to rust proximally. Length, 22-24 mm.

Male: Same as above

Type located: U. S. National Museum, Washington, D. C.

Collected: Lamar, Colorado

Host: Jack rabbit

Cuterebra similis Johnson, 1903

Cuterebra similis Johnson, 1903, Trans. Amer. Ent. Soc. 29:101-102

> Female: Head black, with five more or less triangular pollinose spots on each side contiguous with the eyes, the two occupying the extreme lower angles of the front are fully double the size of those above; those on the face are equal in size, the upper ones being triangular, the others of nearly uniform width; the spots on the inferior orbits are much longer, with a very narrow margin extending upwards along the posterior orbits adjoining the eyes; face and front subshining, punctate and rugosely plicate, and sparsely covered with fine black hairs; vertex with a brownish tinge; antennae black; the plumose aristae becoming yellowish towards the tip.
> Thorax a bluish-black, shining, with fine black hairs, pleura densely covered with long black hair, with only a small tuft of yellow hair below the base of the wing; scutellum more thickly covered with hair below the base of the wing; scutellum more thickly covered with hair than the dorsal portion of the thorax.
> Abdomen shining, steel-blue, sides of the first three segments partly yellowish pollinose, leaving numerous isolated or connected spots of the ground color; along the posterior margin of the first and anterior margin of the second it extends well toward the dorsum.
> Legs black; the femora somewhat brownish, with a white pollinose spot at the base of the posterior femora and on the outer side at the base of all the tibiae. Wings, alulae and squamae, dark brown.
> Length, 21 mm.

Male: Same as above

Type located: Academy of National Science, Philadelphia, Pa.

Collected: Beulah, New Mexico

Host: Unknown

Cuterebra tenebrosa Coquillett, 1898

Cuterebra tenebrosa Coquillett, 1898, Can. Ent. 30:11

> Male: Differs from lepivora as follows: Front at narrowest point five times as wide as the distance between the two posterior ocelli; two spots of brownish pollen on each side of lower part of the front next to the eyes, and two on the sides of the face, but one or more of them sometimes wanting; hairs of the head and thorax wholly black. Abdomen wholly polished and destitute of pollen. Tibiae white pollinose at the base of the outer side. Length, 20 mm. Female: Same as above except that the front is seven times as broad as the distance between the two posterior ocelli. Length, 20 to 22 mm.

Supplementary description: Thorax dark chocolate brown beneath black pile. Abdomen without pollen and appearing a glistening brown.

Type located: U. S. National Museum, Washington, D. C.

Collected: Colorado; Perry, Oregon; and Siskiyou County and San Jose in California.

Host: Pack rat and grasshopper mouse

DISCUSSION

After studying the specimens of Cuterebra in the Museum of Natural History in New York City, New York, and the National Museum in Washington, D. C., it was concluded that the species of Cuterebra in North America could be placed in four groups. (1) Those with buff or yellow pile covering the entire thorax (e.g., C. horripilum, C. cuniculi). (2) Those with the fourth abdominal segment covered with short yellow hairs (e.g., C. fontinella, C. grisea). (3) Those with the entire thorax brown or black (e.g., C. approximata, C. tenebrosa). (4) Those without short yellow hairs on the fourth abdominal segment but having the pleural area with white or yellow pile, with or without a black tuft midway between the wing base and the lateral margin of the eye (e.g., C. americana, C. nitida).

Of the four groups the last three contain species about which very little is known. It was determined by the study of museum specimens that all three of these groups, or complexes, occur in the study area of Utah, Arizona, New Mexico, Colorado, Wyoming, Idaho, and Nevada. Dr. Sabrosky of the National Museum stated that within these groups there are several undescribed species, but without a series of specimens reared from a known host population he was unable to determine the limits of intraspecific variation, making the designation of a true species difficult.

The key to the species of Cuterebra was difficult to construct because it was impossible to begin without first seeing most of the type specimens and comparing them with their original descriptions. When type specimens and original descriptions were not available it was necessary to rely on the descriptions of authors who had redescribed the unavailable type specimens. It is considered by the writer that the description of the male C. atrox by E. E. Austen may not be valid because variation such as he proposed between the sexes of this species does not exist in any other species of this genus in North America.

Problems were encountered in locating populations of animals infested by Cuterebra and rearing the larvae from the infested animals. Probably the most difficult of the above two tasks was locating the infested population of animals. After many weeks of fruitless trapping of rodents in the canyons near Logan, Utah, it was decided to try an area 250 miles from Logan near Manila, Utah in which an infestation of Cuterebra had been reported. This infestation had been located in mid-summer of 1958 by a group of Utah State University entomologists on a collecting trip. Five trips of four days duration each were made to this area during the summers of 1960 and 1961. Once the infested population was located, three determinations had to be made. (1) Size of animal population. (2) Difficulty to trap and keep the host alive. (3) Seasonal occurrence of the parasite. It was impossible to complete these determinations during the first season of trapping, even though three of the five trips were conducted the first season. During each trip fifty live-traps were used to trap the infested chipmunks.

During the first trip in early July of 1960 no parasites were found, but two problems were encountered during this trip. (1) The golden-mantled ground squirrels of the area were found to be more aggressive foragers than the chipmunks. The ground squirrels had to be trapped and caged before the first chipmunk was caught. (2) The traps could not be set overnight because the area was also heavily populated with deer mice, which are primarily nocturnal. On the first morning, every trap contained a deer mouse. This problem was solved by tripping each trap at dusk and then resetting it at daybreak.

The second trip near the first of August resulted in the capture of eight Cuterebra-infested chipmunks, and the third trip one month later yielded 19 infested chipmunks.

After searching the literature and noting the requirements for confining rodents infested by Cuterebra, special cages were constructed. Three or four animals were kept in each cage. After the chipmunks were free from Cuterebra they were released.

The last two trips to the Manila area were conducted in 1961 and resulted in the capture of only six chipmunks parasitized by Cuterebra. The limited success of the last two trips probably can be attributed to heavy rainfall every afternoon which made conditions unfavorable for trapping.

Three specimens of Peromyscus maniculatus infested with C. approximata were trapped in Green Canyon, Logan, Utah, during the fall of 1960 by John Sullivan, a USU graduate student. The infested mice were placed in cages

until the parasites emerged. The last Cuterebra larva emerged from its host on October 24, 1960.

Only a few adult Cuterebra specimens were found in university collections. Contributing to this is the fact that Cuterebra live only a short time as adults (8-14 days), and have, at the most, two generations a year in the U. S. Also, adult Cuterebra are fast fliers, proving elusive to collect, and occur in small numbers in nature.

The difficulty of collecting adult Cuterebra in nature plus the inability of investigators to induce mating under laboratory conditions hinders host-specificity tests. However, experimentation with larvae which resulted from a chance collection of a gravid female Cuterebra, such as that conducted by Radovsky and Catts in 1960, adds greatly to information about the specificity of this parasite.

SUMMARY

The objectives of this study were (1) to determine the species of Cuterebra found in Utah, Idaho, Wyoming, Colorado, New Mexico, Arizona, and Nevada, and to describe any new species found in these areas; (2) to erect a valid key for these species; (3) to develop techniques for rearing Cuterebra; and (4) to compile information as to the host or hosts of each species.

The determination of species of Cuterebra in the study area was accomplished by visiting the Museum of Natural History in New York City, New York, and the National Museum in Washington, D. C., and noting the specimens in their collections and the areas in which these specimens were collected. Also, specimens in the collections of universities in the study area were studied either by a visit to the university or by obtaining the specimens on a loan basis. The determination of new species was found to be impossible at present because of the lack of data involving the three species complexes present in Utah and the neighboring states. However, the evidence available at present indicates that further study will result in the determination of several new species in the three complexes of C. fontinella, C. americana, and C. approximata.

Thirteen described species were found to occur in the study area. A workable key for these species was erected and a description of each species

was prepared. When available the original description was included. If this description, in the writer's opinion, was incomplete, a supplement was added. If the description appeared of no value, then the type specimen was re-described. The descriptions of C. americana and C. atrox by E. E. Austen were substituted for the original descriptions, which were unobtainable.

On five collecting trips during the summers of 1960 and 1961 thirty-three Cuterebra-infested chipmunks were trapped in the Uinta Mountains south of Manila, Utah. Techniques and apparatus were developed for keeping the animals alive in cages and rearing their Cuterebra parasites.

The hosts of the species of Cuterebra were determined by an extensive review of literature and by noting rearing data on the labels of some of the specimens studied. It was impossible to determine the hosts of C. americana, C. atrox, C. nitida, and C. similis because of a lack of host-parasite association data.

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