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North American cuterebrid myiasis Report of seventeen new infections of human beings and review of the disease

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Clinical review

North American cuterebrid myiasis

Report of seventeen new infections of human beings and review of the disease

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Human infection with botfly larvae (*Cuterebra* species) are reported, and 54 cases are reviewed. Biologic, epidemiologic, clinical, histopathologic, and diagnostic features of North American cuterebrid myiasis are described. A cuterebrid maggot generally causes a single furuncular nodule. Most cases occur in children in the northeastern United States or the Pacific Northwest; however, exceptions are common. Most lesions of North American cuterebrid myiasis are caused by second or third instar *Cuterebra* maggots that appear in late August, September, and October. First instar maggots are unusual and occur in the vitreous humor or in the upper respiratory tract of patients in late spring and early summer. (J AM ACAD DERMATOL 1989;21:763-72.)

Myiasis is the disease produced by the invasion of human beings or animals by larvae or maggots of flies. Dozens of species of flies cause myiasis, and the skin is the most common site, but almost any organ may be involved. In their native rodent hosts, *Cuterebra* maggots develop in abscesses just below the epidermis and eventually drop to the ground and pupate. Clinically the lesion resembles a furuncular nodule, referred to as a warble, and the maggot is called a bot. Instar refers to the stage of larval development. Flies that cause this so-called furuncular myiasis are botflies. Several dipteran groups are represented among the botflies.[1]

Dermatobia hominis is the most common cause of human furuncular myiasis in the Western Hemisphere. It occurs mainly in Central and South America but is probably the most frequent cause of myiasis seen in North American clinics. Patients invariably have a history of travel to an endemic area.

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The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the Navy or the Department of Defense.

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Another occasional cause of myiasis in North Americans is *Cordylobia anthropophaga,* the tumbu fly. Patients infected by these larvae are usually recent visitors of parts of tropical Africa.

Myiasis in North American patients who have not traveled abroad is a diagnostic problem. No species of fly in North America normally causes myiasis in man; therefore several incidental myiases are suspect. We reviewed causes of myiasis among North American patients who did not travel abroad. The cases studied were submitted to the Armed Forces Institute of Pathology and to medical entomologists. Almost all these infections were caused by *Cuterebra* species. This finding was surprising because myiasis caused by these flies has not been fully described in the medical literature. This report describes 17 new human infections caused by *Cuterebra* larvae.

Human infection with *Cuterebra* larvae produces North American cuterebrid myiasis. Cuterebrids are restricted to the New World and are represented by two medically important genera, *Cuterebra* and *Dermatobia.* In South America, cuterebrid myiasis is caused by *D. hominis,* but North American cuterebrid myiasis refers to species of *Cuterebra.* Cuterebrids have been reported in persons from Central America, but the larvae were probably species of *Metacuterebra.*[2] There is no evidence implicating a particular species of *Cuterebra* as the cause of human myiasis, because identification of the larvae beyond genus is not presently possible.

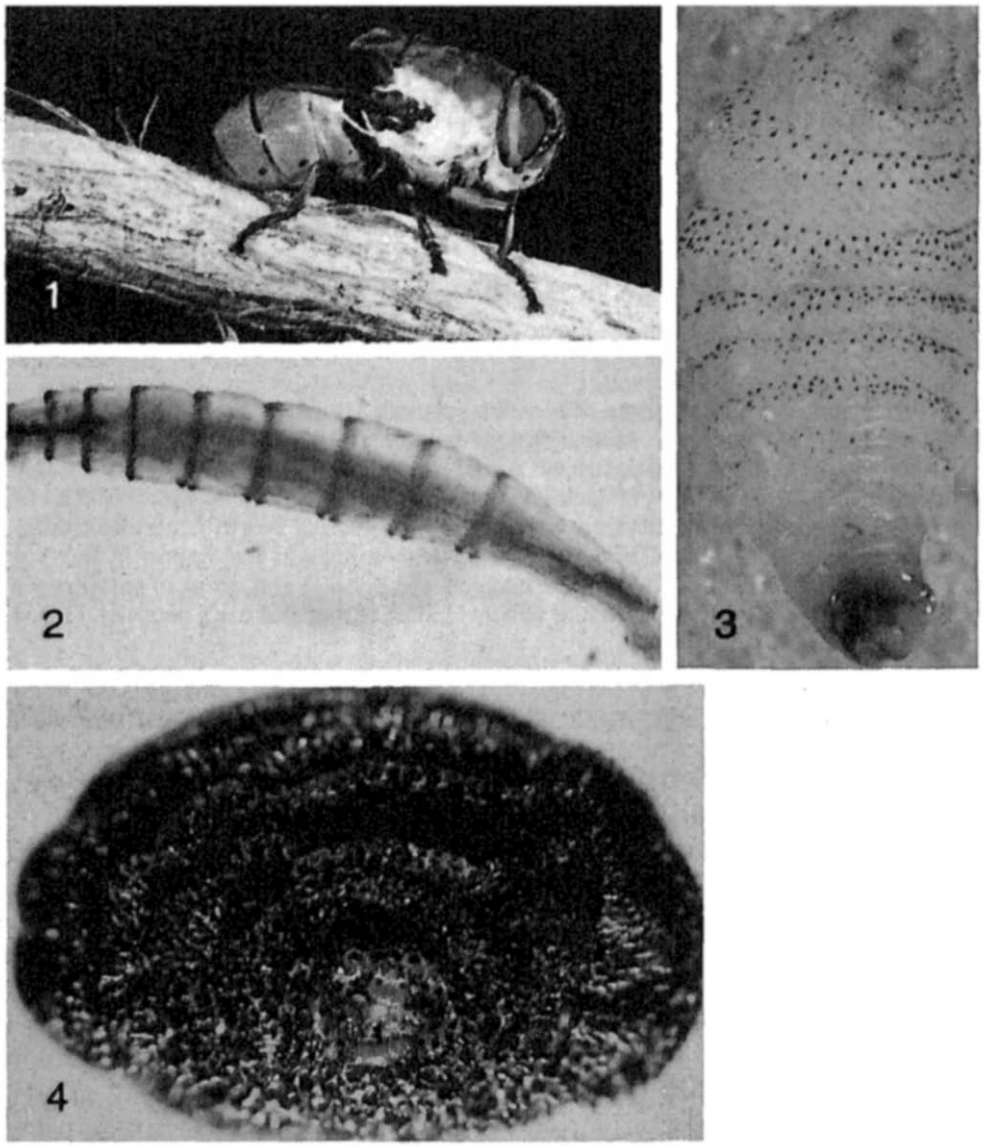

Fig. 1. Adult *C. ruficrus* laboratory-reared from maggot collected from jackrabbit. (×2.5.) (Courtesy C. R. Baird.) (Armed Forces Institute of Parasitology [AFIP] No. 87-5421. [As an educational service, the AFIP offers slides and prints to any U.S. citizen for the cost of production only. Please refer to AFIP number for order.])

Fig. 2. First instar *Cuterebra* maggot. (×18.) (AFIP No. 87-5953.)

Fig. 3. Second instar *Cuterebra* maggot from abscess on cheek of girl living in Massachusetts. (×10.) (AFIP No. 86-1171.)

Fig. 4. Third instar *Cuterebra* larva from warble on scalp of young girl living in Ontario. (×7.) (AFIP No. 87-5125.)

CASE REPORTS

The features of the new cases of North American cuterebrid myiasis are consistent with the 38 cases already described.[3-22] Almost all patients presented in August, September, or October with a single nodule in the skin of the face, scalp, or chest. One patient had a linear urticarial eruption from the shoulder to the scalp above the ear. Most larvae were second or third instars of *Cuterebra* species; one patient had a first instar in the skin of his chest.

A bacterial infection was the usual clinical impression. Most patients were initially treated with antibiotics and

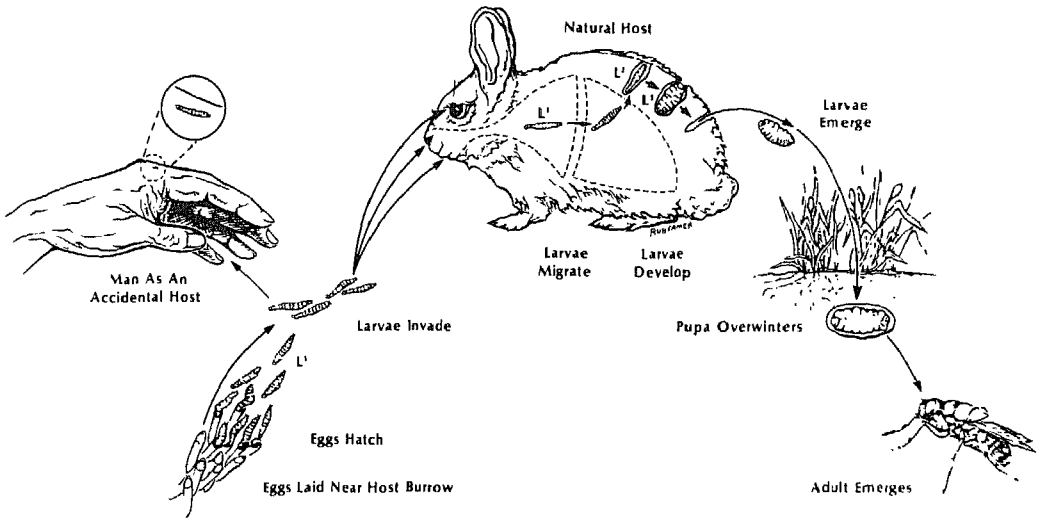

Fig. 5. Generalized life cycle of *Cuterebra* species and incidental infection of human beings.

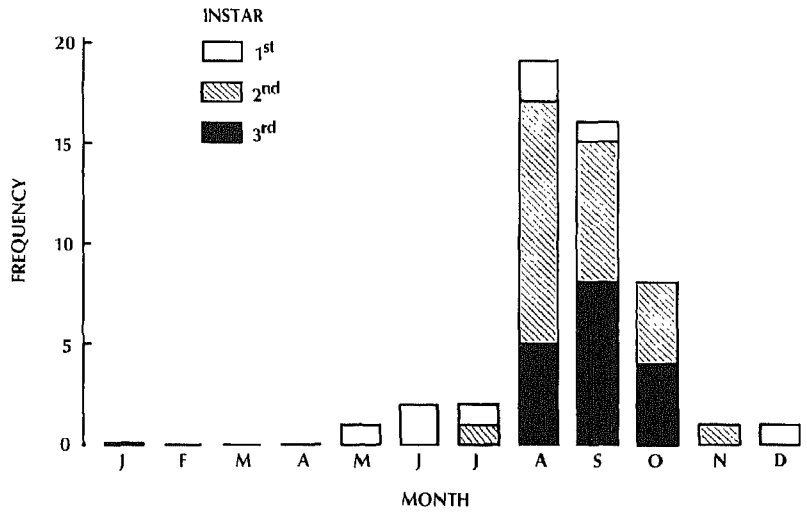

Fig. 6. Seasonal distribution of occurrence of North American cuterebrid myiasis. Data reflect time of clinical presentation of all known infections of human beings.

heat compresses. Accurate diagnosis was made only after larva removal, which was often done by hand at home.

Most patients were young children or infants, but adults were also affected. They lived in rural or semirural areas in or near the northeastern United States. These new infections bring the number of known cases of North American cuterebrid myiasis to 55.

DISCUSSION

Biology

Cuterebrid larvae do not normally infest humans. New World species of rodents, rabbits, and hares are the native hosts.[2,23] Human beings are accidentally infected when they enter the environment of the natural host and contact vegetation and debris that harbor eggs containing infective first instar larvae that are ready to hatch.

Adult *Cuterebra* are large, bumblebee-like flies (Fig. 1). They lay their eggs near the trails or burrows of the natural host. Infective first instar larvae (Fig. 2) emerge from the egg in response to warmth, perhaps host warmth. They adhere and seek a portal of entry—nose, eyes, mouth, or anus[23]—or they may directly penetrate skin,[4] especially lacerated skin. In rabbits the first instars penetrate the mucosa and migrate to the trachea, where they enter the pleural cavity.[24] The larvae then penetrate the diaphragm and migrate through the abdominal cavity. They eventually enter the dermis, where they de-

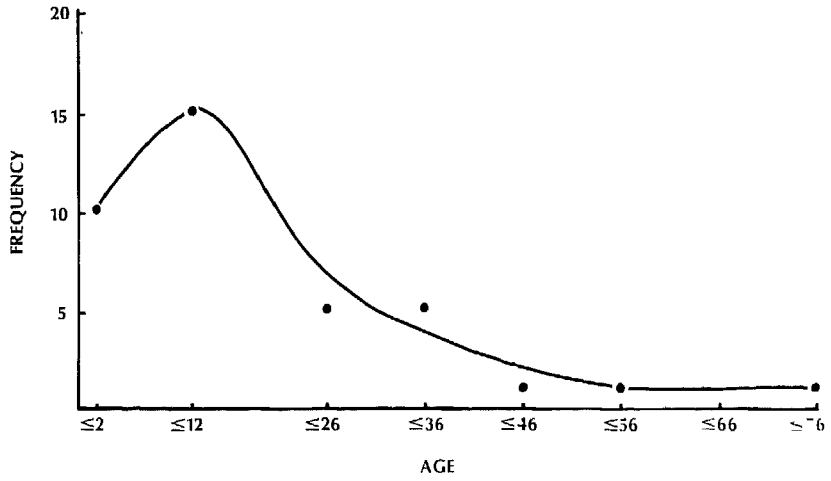

Fig. 7. Age distribution of patients with North American cuterebrid myiasis.

Fig. 8. Geographic distribution of known infections of human beings by *Cuterebra.*

velop individual warbles and molt twice to become second and third instars (Figs. 3 and 4).

The route of migration of cuterebrid larvae in humans is unknown. The variety of lesions suggests that there may be several mechanisms. For example, the presence of larvae in the eyes, nose, or trachea of human beings indicates that larvae seek mucous membranes and attempt migration through deep organs, as described in some animals. In contrast, other first instars penetrate skin and develop at the site of penetration (some patients describe a prior sharp sting at the warble site or have a first instar in the skin) or migrate through the subcutis to another site (such patients have a creeping eruption).

The time required for a mature larva to develop in human beings is unknown. This is because the larvae are removed before their development is complete. In native rodent and rabbit hosts, this time is variable among *Cuterebra* species but is consistent within each host-parasite relationship; for example, the time to maturity is 19 days for *C. fontinella* in woodmice but is 73 days for *C. ruficrus* in jackrabbits.[23] After the final molt, the third instars achieve the most significant growth and begin to en-

Table I. New infections of human beings by *Cuterebra* species

Date (mo, yr)	Geographic location	Patient (Age [yr]/Sex)	Anatomic location	Instar
Sept. 1971	Pennsylvania	26/M	Chest	2
Aug. 1978	Ohio	2/F	Eyelid	2
Aug. 1979	Massachusetts	7/F	Face	3
Aug. 1979	Massachusetts	8/F	Face	3
Sept. 1981	Ontario	2/F	Scalp	3
Aug. 1982	Maine	1/M	Leg	2
Aug. 1982	New Hampshire	4/F	Chest	1
Aug. 1984	Vermont	30/M	Chest	2
Aug. 1984	S. Carolina	Child/F	Eyelid	3
Aug. 1985	Vermont	27/M	Face	2
Sept. 1985	Maine	NA/M	Eyelid	2
Sept. 1986	Maryland	73/M	Neck	2
Oct. 1986	Vermont	42/F	Eyelid	2
Oct. 1986	Vermont	4/F	Eyelid	3
Oct. 1986	W. Virginia	12/F	Face	2
Oct. 1986	W. Virginia	Adult/F	Eyelid	2
Oct. 1986	Alabama	28/M	Eyelid	2

NA, Data not available.

large their warble pore in preparation for exiting the host. They back out of the pore, drop to the ground, and burrow several inches below the surface, where pupation and overwintering occur (Fig. 5). Sexually mature flies emerge 30 to 600 days later, depending on species and environmental conditions. Adult flies do not feed; they mate, lay eggs, and die within a 2- to 3-week lifespan.[23]

Epidemiology

First-instar larvae are less than a millimeter long. Patients, particularly children, may inadvertently acquire the infective larvae on their fingers and introduce them into facial orifices. Petting and kissing the family dog or cat that has acquired larvae on its fur may also result in transfer of the larva to human beings. This may be why children are more commonly infected than any other age group (Fig. 6).

Almost all patients presented in late August or early September (Fig. 7) with second or third instars. The few patients that presented earlier in the summer had first instars.[7,8] This finding suggests that patients are exposed to infective larvae earlier in the summer and that symptoms develop later. Time of exposure corresponds to the time of year adult cuterebrids briefly appear and lay eggs. Eggs may bear viable infective first instars for several months after oviposition and development, however[23]; this may explain why a patient was seen in December with a first instar.[22]

Most infections by cuterebrids are reported from the northeastern United States. The distribution includes most of temperate North America except the high plains and the Rocky Mountains (Fig. 8). Such a distribution may reflect the relative density of the human population (i.e., more cases are reported because more persons are exposed). Similarly, this distribution may reflect the population density of the natural host and/or parasite. Human cuterebrid infections[18,25] reported from Central America were probably caused by *Metacuterebra* species.[2,26]

Clinical findings

Cuterebrid larvae appear almost anywhere on the body, but most are in subcutaneous abscesses on the face, scalp, neck, shoulders, or chest. Infections have occurred on the arms, abdomen, buttocks, scrotum, and legs, but these sites account for less than 15% of reported infections. Five cases of larval infection have been described in the vitreous humor and three in the upper respiratory tract (Tables I and II).

The usual human lesion is an erythematous papule, 2 to 4 mm in diameter. It may have a central pore through which the larva breathes, but this may not be noticeable. At least two patients have had creeping eruption caused by a cuterebrid larva. In one patient a linear urticarial tract, extending from the shoulder to the scalp just above the ear, had a mature warble that contained a third-instar maggot.

Table II. Reported infections of human beings by *Cuterebra* species

Date (mo, yr)	Geographic location	Patient (Age [yr]/Sex)	Anatomic location	Instar	Reference No.
July 1941	Virginia	36/F	Nostril	1	3
July 1942	Kansas	Adult/M	Arm	1	5
Sept. 1945	Massachusetts	Adult/M	Thorax	3	4
Aug. 1954	Washington	1/M	Neck	3	6
Apr. 1955	Louisiana	NA	NA	NA	7
Aug. 1962	Louisiana	NA	NA	NA	7
Aug. 1962	N. Carolina	10/M	Face	2	8
May 1967	Alabama	45/F	Eye	1	9
Aug. 1968	Georgia	Adult/M	Knee	3	10
Sept. 1969	Connecticut	51/M	Eyelid	3	11
June 1970	California	43/F	Eye	1	12
Oct. 1970	Massachusetts	7/M	Axilla	3	8
Sept. 1971	Virginia	26/M	Thorax	2	*
1972	Alabama	Child/M	Abdomen	NA	*
Aug. 1973	Maine	10/M	Face	2	*
Sept. 1973	Vermont	Child/M	Thorax	2	*
Oct. 1973	W. Virginia	Adult/M	Scrotum	2	*
Oct. 1973	Pennsylvania	10/M	Eyelid	3	13
1975	New York	Child/M	Neck	3	*
Sept. 1976	Oregon	34/M	Thorax	3	†
Sept. 1976	Pennsylvania	16/F	Eyebrow	1	14
July 1977	Ontario	12/M	Thorax	2	15
Sept. 1977	Ontario	22/M	Trachea	2	16
1977	Canada	12/F	Face	2	17
1977	Maine	7/NA	Thorax	3	*
Aug. 1978	Washington	Infant	Neck	3	†
Oct. 1978	Ontario	13/M	Forehead	3	16
Aug. 1979	Oregon	22/M	Bronchus	2	†
1979	Kentucky	1/F	Chin	2	17
Sept. 1979	Missouri	Infant	Face	3	†
Aug. 1980	Connecticut	1/F	Eyelid	2	18
Aug. 1980	Minnesota	Infant	Face	3	†
Sept. 1980	New Hampshire	35/F	Arm	3	†
1980	Kansas	15/M	Eye	1	19
Oct. 1981	N. Carolina	11/M	Eye	1	20
Sept. 1982	Pennsylvania	3/M	Forehead	2	21
Dec. 1983	Georgia	33/M	Eye	1	22

NA, Data not available.
*Unpublished record of the U.S. Department of Agriculture, as cited by Baird et al.[19]
†Personal communications cited by Baird et al.[19]

The other patient had a similar tract from the nares to the eyelid.[8]

The nodule may be tender or nontender, and the patient may be aware of movement within the nodule. In fact, many patients excise the larva themselves and present it for identification. Some patients describe at the site of the nodule a sharp sting that occurs 1 to 2 weeks before clinical presentation. Penner[5] described this when he let laboratory-reared first instars penetrate the skin of his forearm. These cases suggest that larvae can penetrate intact skin and develop in the dermis without migrating through other tissues.

A patient with a larva in the trachea coughed it up, and one patient with a larva in the nose sneezed it out.[16,17] First instars in the vitreous humor may cause intermittent blurred sight as they float in and out of the field of vision. Other patients describe either no symptoms or episodes of extreme pain without loss of acuity of vision. Evidence of subretinal tracks is reportedly pathognomonic for ophthalmomyiasis.[27]

Table III. Clinical findings in North American patients infected by dipteran larvae

Larva	Geographic location	Anatomic location	Time of yr (mo)	No. larvae/warble (No. warbles/host)
Cuterebra sp.	Eastern U.S., Ontario, Pacific Northwest	Head, neck, face, chest, vitreous humor	Aug., Sept., Oct.	1 (1)
Dermatobia hominis	Central and S. America	Exposed skin, scalp common	Anytime	1 (1)
Cordylobia anthropophaga	Tropical Africa	Exposed skin, back common	Anytime	2-3 (1-4)
Hypoderma bovis	Northern U.S.	Face, scalp	Dec., Jan.	1-3 (1)
Wohlfahrtia vigil	Northern U.S., Canada	Head, neck, face, chest	June, July	1 (5)
Gasterophilus sp.	Cosmopolitan	Skin, creeping eruption	Anytime	No warble
Oestrus ovis	Western U.S.	Conjunctiva	Anytime	No warble

Table IV. Comparative histopathologic characteristics of ticks, mites, *T. penetrans,* and selected fly larvae

Organism	Anatomic location	Cuticle (μm)	Spines	Hypodermis
Tick	Above keratin	≤50	Yes	Yes
Mite	Epidermis	<5	Yes	No
T. penetrans	Epidermis	>20	No	Yes
Dipteran larvae	Dermis	Variable	Yes	Yes
Cuterebra				
2nd instar		<5	<15 μm*	
3rd instar		>50	Large, cover body*	
D. hominis		>50	Large, sparse*	
Cordylobia anthropophaga		>25	Smaller, less sparse*	

*See Fig. 12.

All patients with North American cuterebrid myiasis had been infected by a single larva that caused a single lesion. This is an important distinction in its differentiation from other forms of myiasis.

Histopathologic changes

Cuterebrid larvae cause skin changes similar to those caused by other dipteran larvae. A cystic sinus tract filled with pus contains the larva. The sinus wall may become epithelialized in mature warbles. Tissue surrounding the sinus is edematous and infiltrated by eosinophils, histiocytes, lymphocytes, and plasma cells.

Diagnosis

Clinical diagnosis. Diagnosis of North American cuterebrid myiasis of skin may be made on the basis of clinical presentation and gross appearance of the intact larva. Identification of the genus is relatively simple and suffices for diagnosis, but identification of the species is not presently possible.

A patient's history of travel is important in anticipating the genus of fly larva causing myiasis. Patients who return from Central or South America or from Africa are probably infected by *D. hominis* or *Cordylobia anthropophaga,* respectively. Infection by *Tunga penetrans* may resemble myiasis. *T. penetrans* is a flea that invades the skin and produces a furuncular nodule.[28] Tungiasis, however, is almost always on the feet, where myiasis is rare.

Cuterebrid myiasis is probably the most common kind of myiasis in patients who have not traveled abroad, but *Hypoderma bovis,*[29] *Wohlfahrtia vigil,*[30] or *Gasterophilus* species[31] may also cause myiasis in the skin of persons living in North America. These varieties may be distinguished from cuterebrid myiasis by their clinical presentation (Table III). *H. bovis* appears in patients during the winter, and there may be more than one larva per

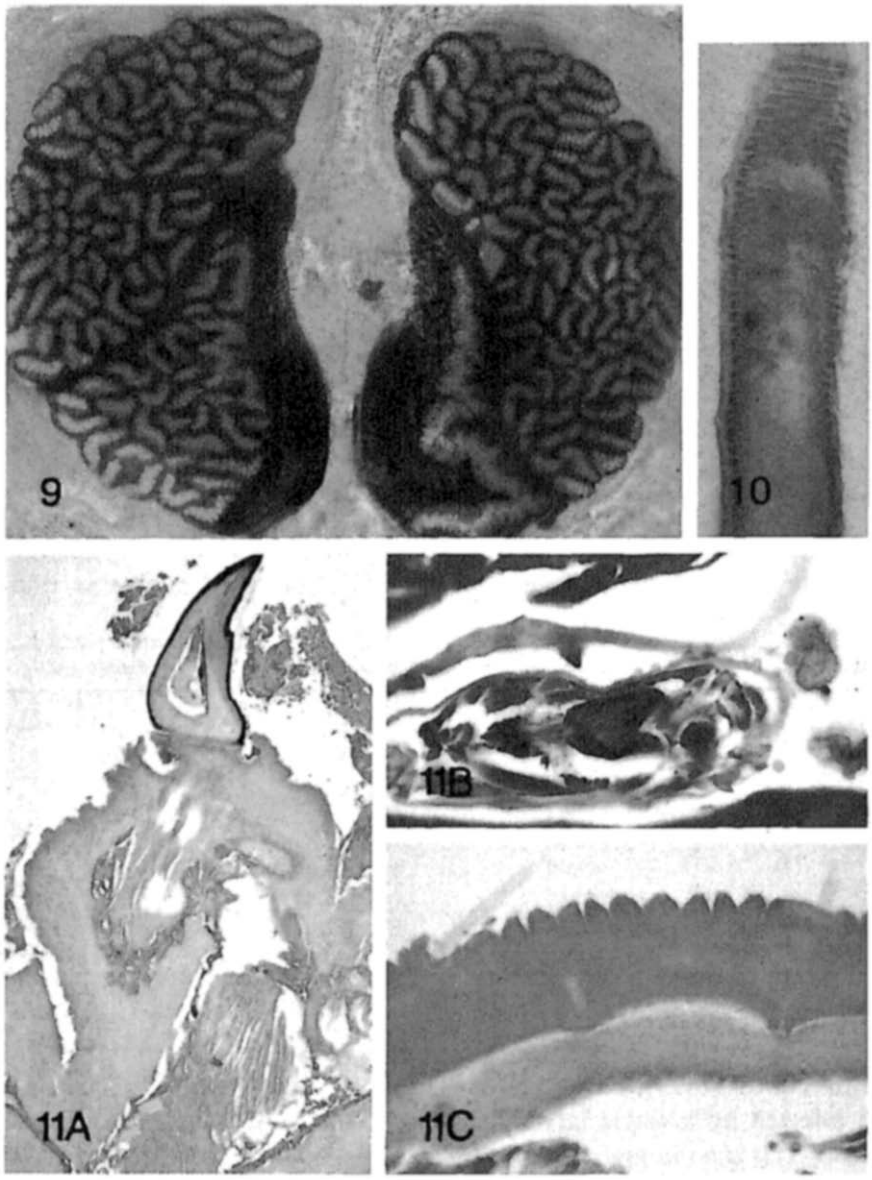

Fig. 9. Respiratory spiracular plates from posterior end of third instar maggot. (Hematoxylin-eosin stain; ×60.) (AFIP No. 87-5480.)

Fig. 10. Histologic section of respiratory tubule of fly larva. (Hematoxylin-eosin stain; ×630.) (AFIP No. 86-10122.)

Fig. 11. Histologic sections of arthropods. **A**, Fly larva; **B**, mite; **C**, tick. (**A**, Hematoxylin-eosin stain; ×60 [AFIP No. 87-5390]. **B**, Giemsa stain; ×180 [AFIP No. 87-5418]. **C**, Hematoxylin-eosin stain; ×400 [AFIP No. 87-5389].)

warble and almost always more than five warbles per patient.[30] *Gasterophilus* species cause a serpiginous urticarial tract, not a nodule.[31] In contrast, *Cuterebra* produces a solitary warble in human beings in late summer; no warbles contain more than one larva.

The gross morphology of cuterebrid maggots is sufficiently distinct to permit their identification. In general, first instars are relatively slender (1 to 6 mm × 0.2 to 1.4 mm) with six to eight distinct bands of spines; the anterior rows are relatively large. A characteristic posterior adhesive organ may be visible (Fig. 2). Second instars are plumper (5 to 10 mm × 2 to 4 mm) with smaller and less noticeable bands of spines (Fig. 3). Third instars are robust (10 to 20 mm × 4 to 10 mm) (Fig. 4). Third instars do not exhibit well-ordered bands of spines; instead, the spines are heavily pigmented and densely set to cover

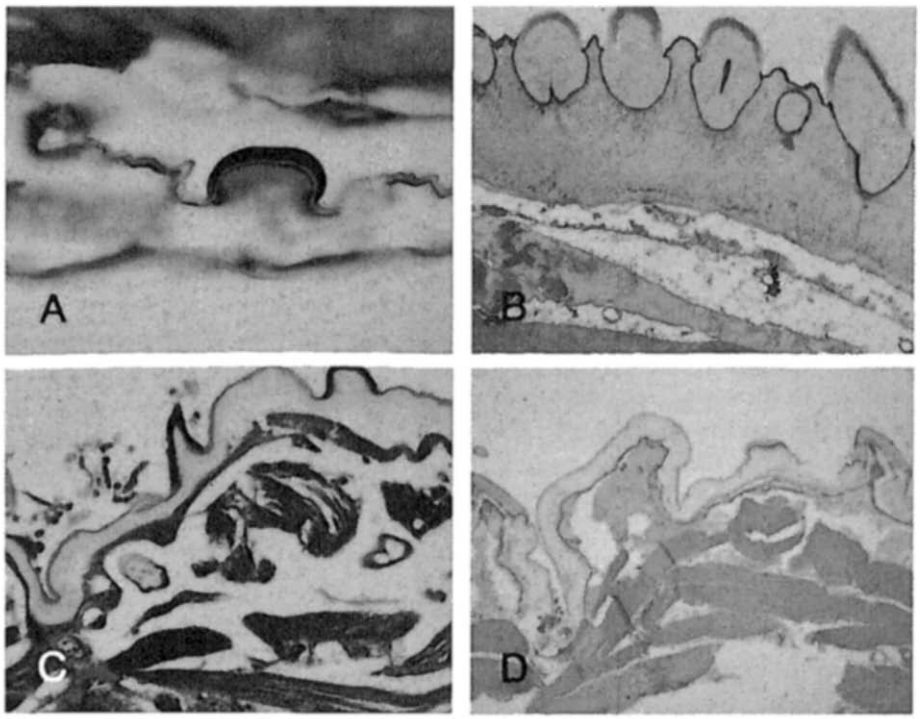

Fig. 12. Histologic sections of fly larvae. **A,** Second instar *Cuterebra* maggot; **B,** third instar *Cuterebra* maggot; **C,** maggot of *Cordylobia anthropophaga;* and **D,** maggot of *D. hominis.* (**A,** Movat pentachrome stain; ×180 [AFIP No. 87-5123]. **B,** Hematoxylin-eosin stain; ×60 [AFIP No. 87-5488]. **C,** Movat pentachrome stain; ×45 [AFIP No. 87-5489]. **D,** Hematoxylin-eosin stain; ×60 [AFIP No. 87-5391].)

completely the body of the maggot. Grossly, mature third instars are nearly black or brownish when alive or newly killed. Less mature third instars may be covered with cream-colored spines. Examination of the anterior end with a magnifying glass or a stereomicroscope may reveal prominent hooklets. The appearance of the spiracles on the posterior end is specific for the genus (Fig. 9). A more complete morphologic description of the immature forms of *Cuterebra* is available.[32]

Diagnosis of internal ophthalmomyiasis is by slit lamp examination. First instars invariably cause the ophthalmomyiasis of North American cuterebrid myiasis. The gross morphology of these maggots is characteristic, and locating them provides the diagnosis.[22] Subretinal tracks are considered pathognomonic for posterior ophthalmomyiasis, but this may be caused by several species of fly larvae.[27] *Cuterebra* apparently does not infect the human conjunctiva, a common site for larvae of *Oestrus ovis,* the nasal bot of sheep, which is the most common cause of ophthalmomyiasis in human beings.

Histopathologic diagnosis. The histopathologic features that distinguish fly larvae from helminth parasites in skin include striated muscle and tracheal tubules of the spiracular system (Fig. 10). *T. penetrans,* ticks, and mites also have these characteristics but can be distinguished from fly larvae (Table IV). First, these arthropods are rarely in the reticular dermis, which is the usual location for fly larvae. Mites lack a discernible hypodermis, and the absence of spines suggests *T. penetrans.* When spines of a tick, mite, or fly larva are present, they may be easily distinguished, as illustrated in Fig. 11.

Characteristics of the cuticle and spines distinguish North American cuterebrids from other maggots that cause furuncular myiasis. The key feature in second-instar larvae of *Cuterebra* is diminutive spines (25 μm or less in diameter). Large spines covering the thick (100 μm) cuticle is the key feature of third-instar cuterebrid maggots. For example, larvae of *D. hominis* also have large spines and a relatively thick cuticle, but the spines are widely spaced. *Cordylobia anthropophaga* is distinguished from *Cuterebra* by its spines, which are much larger than those of the second instars, and by its relatively

thin cuticle, which is less than one fifth as thick as the cuticle of third instars. All these features are illustrated in Fig. 12 and are summarized in Table IV.

Treatment

Treatment involves removal of the larva and prevention of secondary bacterial infection. A protocol for this is not practical because myiasis is usually not suspected before the larva is excised. In most patients the larva is expressed by hand. When myiasis is suspected, a warble containing a second or third instar is usually present. In these warbles, the patient can feel the larva moving and the clinician may see the posterior end of the larva through the warble pore. A thick application of petroleum jelly over the warble pore may force the larva out for air.

Treatment of internal ophthalmomyiasis depends on the condition of the eye.[20] Vitrectomy to remove the larva is indicated if inflammatory changes are causing damage. Some physicians have managed removal without surgery, by use of topical corticosteroids.[22] Photocoagulation may be indicated in some patients in lieu of surgery.[33] A dead larva in the vitreous humor that does not provoke inflammation need not be removed. The larva is eventually absorbed without adverse effects.[22]

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