The morphology of the larval instars and pupa of Dermatobia hominis L. Jr. (Diptera: Cuterebridae)[1])

by

J. A. JOBSEN[2]) and H. MOURIER[3])
Programa Cooperativo de Investigación sobre el Tórsalo, OIRSA, Apartado Postal 789, Tegucigalpa D.C., Honduras C.A.

Introduction

In many areas of Latin America, *Dermatobia hominis* (called with many names, among which tórsalo) infestation is a serious limitation to profitable cattle production. The success of the sterile-male method in eradicating the screw-worm, *Callitroga hominovorax* (Coquerel) from Curaçao and the Southeastern United States (Bushland, 1960) suggested the possibilities of using sexually sterile insects for the control or eradication of other species (Knipling, 1955 and 1964). Several workers pointed out that this might be a feasible way to control *Dermatobia* and this furnished economic justification for research on the sterile-male approach to this species. A method of mass rearing *Dermatobia*, either by means of natural hosts (Banegas et al., 1967) or in artificial media (Rasmussen and Jobsen, in MS) is necessary. Studies along these lines needed a method for separation of the larvae into the respective instars to permit evaluation of the relative success of the different media.

Newstead and Potts (1925) gave a very precise description of the first instar larva, particularly the mouthparts were studied in detail. Townsend (1935) briefly described the other instars. He found four larval stages, while the generally accepted number is three. A study has been published recently by Katiyar et al. (1967).

Some notes on the life history

The life history and occurrence of *Dermatobia* has been described by several workers, most recently by Neel et al. (1955), Koone and Banegas (1959) and Andersen (1962). Other papers deal specifically with the mating (Banegas and Mourier, 1967) and egglaying behaviour (Mourier and Banegas, 1970).

The normal life cycle (fig. 1) is summarized as follows: The female fly catches other day-flying adult Diptera and attaches its eggs to the phoretic carrier by gluing a mass of several, to more than a hundred eggs, to the abdomen of the carrier insect. The vector species may differ from region to region: mosquitoes or

[1]) This study is a phase of a cooperative research programme undertaken by the Organismo International Regional de Sanidad Agropecuaria (OIRSA) and the Ministerio de Recursos Naturales, Republic of Honduras. It was currently supported by the Danish Government, the International Atomic Energy Agency (IAEA) and the Food and Agriculture Organization (FAO) of the United Nations. Any statement presented in this paper does not necessarily reflect the viewpoint of FAO.

[2]) FAO Associate Expert (Netherlands). Present address: Plantenziektenkundige Dienst (Plant Protection Service), Geertjesweg 15, Wageningen, The Netherlands.

[3]) Present address: Statens Skadedyrlaboratorium (Government Pest Infestation Laboratory), Skovbrynet 14, 2800 Lyngby, Denmark.

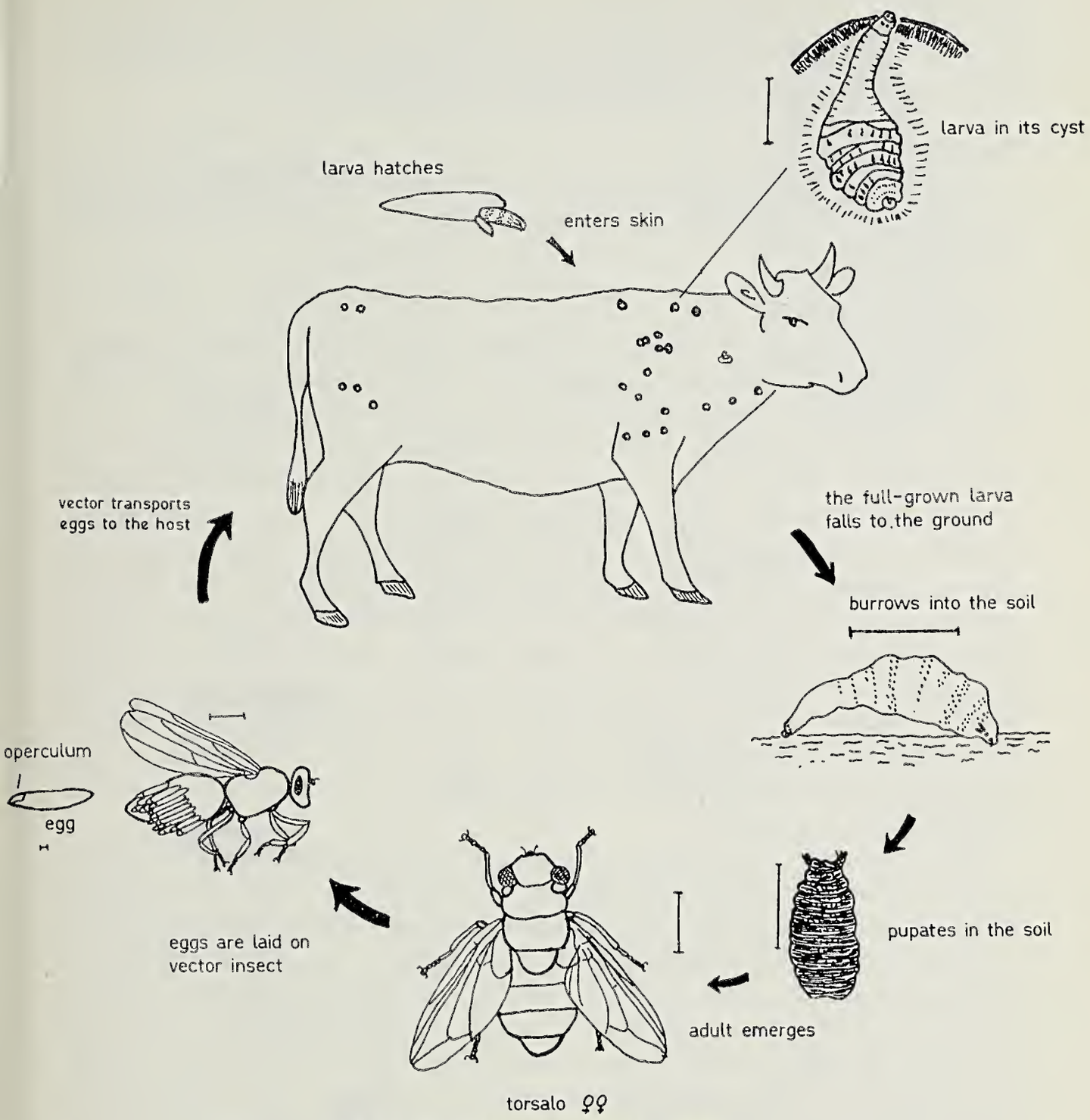

Fig. 1. Life cycle of *Dermatobia hominis.*

flesh flies, which visit the potential hosts of *Dermatobia.* The hosts are a wide variety of wild animals, a number of domestic animals and man. The main economic damage is in cattle. When the eggs are ready to hatch, the larvae emerge in response to the warmth of a host, when this host is visited by the carrier. The larvae penetrate the skin and lodge in the subcutaneous tissue; they do not migrate within the host but encyst at the point of entrance. A breathing hole is maintained by the larva throughout its development. The average larval period in cattle is 40—60 days. Our results showed that in the dry season it can be as long as 120 days. We also found that the average duration in goats is about the same; in guinea pigs 35—50 days; in mice 25—35 days; in rats 30—40 days. In the rat the

first moult occurs 6—10 days after inoculation, the second one after 16—20 days. The full-grown larvae leave the host by crawling through the enlarged breathing hole, fall to the ground, burrow into the soil and pupate. We were never able to find males in the field. In literature it is mentioned only once.

Material

Some of the larvae studied were reared in artificial media, others were squeezed from animals in the field and in laboratory colonies or from hides, shortly after slaughter.

General description

We have observed two moults, consequently, three instars are distinguished. 200 larvae were weighed and measured, the results appear from table I. The general morphology of the different instars appears from the figures 2—5.

The smooth cuticle of the larva is white-yellowish, apart from the spines. One pseudocephalic, three thoracic (number 1—3) and eight abdominal (number 4—11) segments are visible. Segmental lines are faint. The pseudocephalic segment is unsclerotized, bilobed, with three sensory organs on each lobe: one relatively large, one small and one which might be the antenna. The proximal portion of the supposed antenna has a sclerotized band, the terminal part is translucent. The mouth aperture is located ventrally. The mouthparts are of the type common in Muscidae: a pair of hook-shaped mandibular sclerites, which basally articulate with the small gutter-shaped hypostomal sclerite. Most caudal is the pharyngeal sclerite, a large ventrally united trough. The length of the sclerotized portion of the cephalopharyngeal skeleton is the best characteristic for identification of the instar.

The thoracic and most abdominal segments are provided with heavily sclerotized spines which, with a few exceptions, point to the rear. There are two types of spines: big ones (macrospines) and small ones (microspines). The arrangement of the microspines has a typical pattern in the different instars. The macrospines are grouped in rows, six in total: one row near the caudal margin of the segments 4, 5 and 6, and one row near the frontal margin of the segments 5, 6 and 7. The rows near the frontal margin ring the entire body, but of those near the caudal, one third of the ring is lacking on the ventral side. The size, form and colour of the spines are characteristic and can be used to distinguish the different instars. In early literature the number of spines was used to distinguish different species within *Dermatobia*. Van Thiel (1924) did so, following Blanchard (1892). For each instar the spines of 20 individuals were counted. In the first two instars the numbers are more or less the same. Averages and ranges per segment in sequence are resp.: 18 (16—21); 26 (20—28); 16 (14—20); 26 (22—28); 14 (12—20); 23 (20—25). For the third instar these figures are: 28 (22—34); 46 (42—48); 28 (24—33); 44 (42—46); 24 (20—30); 40 (38—42). These spines help the larva to enter the host, irritate the tissue to create the specific environment and release of nutrients, and at the same time keep the larva in place. The last two abdominal segments are furnished with delicate forward pointing spines. These probably help to keep the breathing hole open.

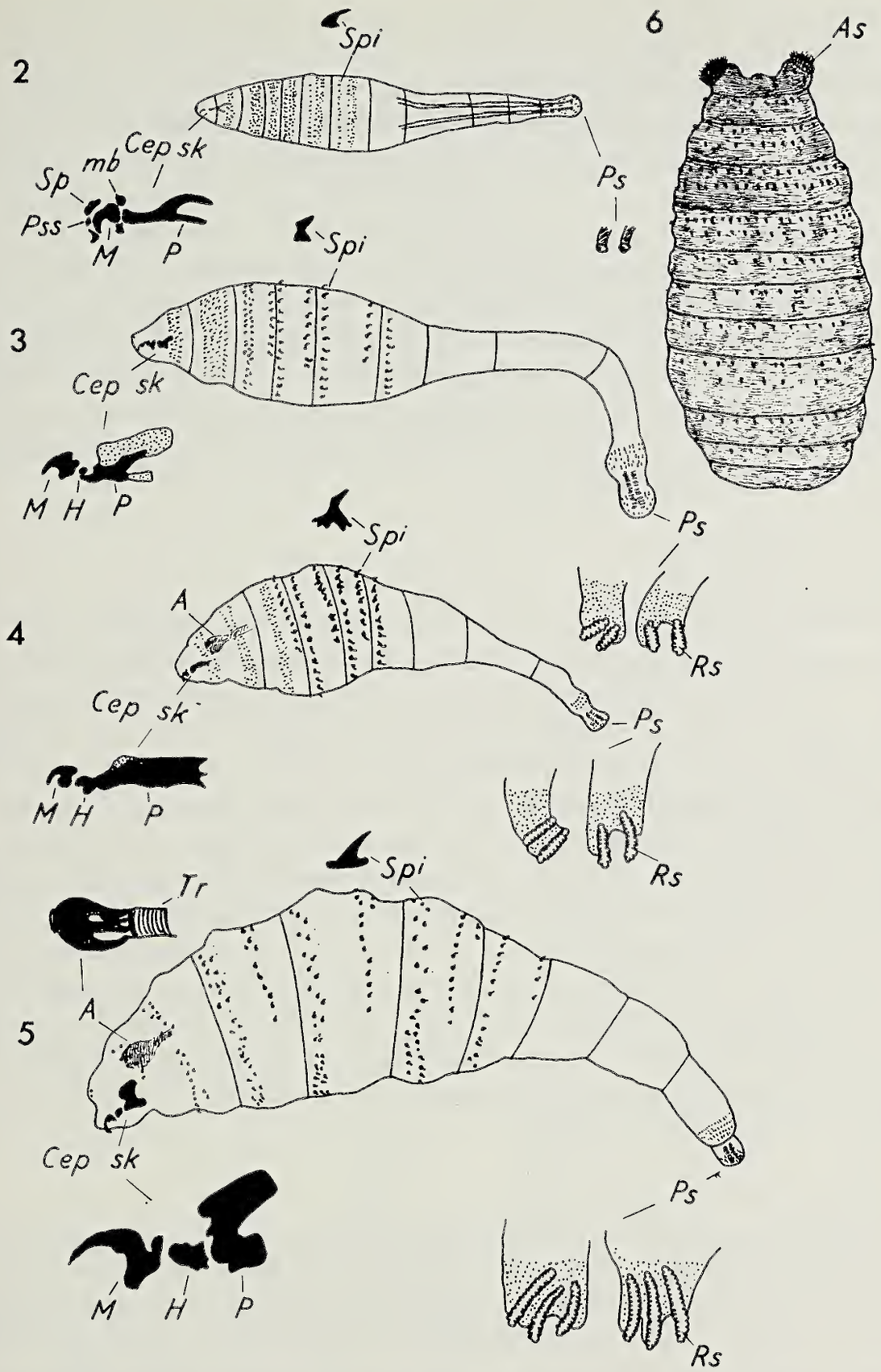

Fig. 2—6. *Dermatobia hominis*. Larvae and pupa. 2, First instar; 3, Young second instar; 4, Older second instar; 5, Third instar; 6, Pupa. Cep sk, cephalopharyngeal skeleton; M, mandibular sclerite; H, hypostomal sclerite; P, pharyngeal sclerite; mb, membranous band; Sp, stomal plate; Spi, macrospines; Ps, posterior spiracle; Rs, spiracular opening; A, anterior spiracle (closed); Tr, trachea; As, anterior spiracle (open).

The anterior spiracles are situated on the first thoracic segment, but are non-functional, i.e. the larva is metapneustic. The functional posterior spiracles are situated on the last visible abdominal segment; they have no peritreme. Each posterior spiracular plate hase one spiracular opening in the first, two in the second and three in the last instar. The last abdominal segments can be retracted and the spiracles closed.

Some changes occur in the course of each stage. The sclerotization of unsclerotized parts of the cephalopharyngeal skeleton and the spines continues; this is most pronounced during the second stage. (Sclerotized parts are most easily visible and are measured.) Since the development of the larva is relatively slow, it is perhaps rather natural to find larvae that are clearly intermediate between stages, where, e.g. the newly formed skin can be seen through the old skin. During the last part of the second stage, even without new skin present, pre-formed parts of the third instar larva are found.

Detail description

First instar larva

The shape of the newly hatched larva is subcylindrical, tapering caudally (fig. 2). Besides the cephalopharyngeal skeleton, there are some accessory sclerites, described in detail by Newstead and Potts (1925). Proximal to the mandibular sclerite is a thin sclerotized band, the prestomal sclerite. On both sides of the same sclerites is a cone-shaped, distally-converging structure, the stomal plates. These resemble a pair of hooks, quite blunt, furrowed and set with minute spines. Near the base of the mandibular sclerites is a pair of slightly sclerotized membranous bands. The thoracic segments and the first abdominal segment are thickly set with microspines; they occur in smaller numbers on the other segments. Only on larvae of this instar are microspines present in the rows of macrospines, alternating with the macrospines. The sclerotization of the macrospines continues until the final size is four times the original one. The tracheal trunks are visible through the skin. Anteriorly they seem to end blindly; posteriorly they appear as two yellow tubes, which unite at the end. The posterior spiracular plate is slightly sclerotized with one round, indistinct aperture.

Second instar larva

After the first moult the larva becomes pyriform (fig. 3). The spined anterior half is ovate to globular, while the bare posterior half is narrow and attenuate; later, the anterior part broadens somewhat and comprises a little less than half of the larva (fig. 4). The cephalopharyngeal skeleton of the young second instar is similar in shape to that of the third instar, but later changes. The visible unsclerotized portion grows and also the sclerotization continues, until the sclerotized portion becomes twice as big. The shape has become more elongated. The size of the macrospines increases four times due to sclerotization and the shape changes from the simple circular base by enteriad dendrite branching (fig. 4). Microspines are also present in large numbers on the thoracic segments. A small group of them occurs on the segment 4, 5 and 6 around the median dorsal line in the open space in the caudal rows of macrospines. They point anteriorly. The atria of the anterior

spiracles can be seen through the skin as brown enlargements which are closed, as in the first instar. The posterior spiracular plates are weakly sclerotized. In this and the last instar the respiratory slits are furnished with a row of denticles, forming a filter. Rather early in this stage the mandibular sclerites of the last instar are formed, dorsal to the existing ones. At the same time, newly formed spiracular plates with three large slits can be found.

Third instar larva

The young third instar larva has a relatively short ovate fore-part and a long slender hind-part, but this shape changes when full-grown to elongate ovate (fig. 5). The fore-part has lengthened and the hind-part broadened and shortened. The colour of the skin also changes: from whitish to yellowish and the spines from red-brown to dark-brown. (The spines of the larvae of the other instars are black.) The macrospines have a simple shape with a broad nearly circular base. The rows of macrospines near the anterior margin are double. The rather large microspines on the abdomen form an irregular row posterior to the anterior row of macrospines on segments 5, 6 and 7. Groups of anteriad directed microspines are present as in the second instar, but here there is also one on segment 7. The pro-thoracic spiracles are apparently closed until the larva leaves the host. The atrium is a large, light brown sclerotized structure, which is easily seen through the skin.

Sometimes the anterior spiracles open already inside the host, probably when the emergence is retarded, however, this generally happens in a spectacular way after the larva has left the host, when thousands of small growing papillae may be seen. Upon emergence, the weight of the larva ranges from about 400 to 1000 mg. The mature larva is strongly negative fototactic and burrows into the soil, typically making a half circle and consequently pupating with the head upwards.

Table 1. Weights and measurements of the larval instars.

In-star	Length of body in mm		Final weight in mg		Length of mouthparts *)	
	min.	max.	min.	max.	min.	max.
1	1.5	6	0.5	0.8	0.2	0.25
2	5	15	50	80	0.5	1.0
3	13	24	400	1000	1.9	2.5

*) i.e. the sclerotized part of the cephalopharyngeal skeleton.

Pupa

The pupa is enclosed in a heavily sclerotized puparium formed by the skin of the third instar larva. Due to shrinking, the puparium is somewhat shorter than the mature larva (fig. 6). During the first 10 days the pupa changes colour from yellowish to light brown, to dark brown, to nearly black. The large brush-shaped anterior spiracles remain conspicuous. A fine seam appears on the puparium ventrally to the anterior spiracles, circumscribing the operculum through which the fly emerges.

Summary

Dimensions and morphological characteristics are given that enable to distinguish the three instars of *Dermatobia hominis*. The length of the body reveals some overlap: for I—II around 5—6 mm and for II—III around 13—15 mm. The main characteristics are summed up in the following key:

1. Length of the cephalopharyngeal skeleton (c.sk.) below 0.25 mm. Other mouthparts besides the c.sk. Microspines present in between macrospines. 1 slit in each posterior spiracular plate . . . . . Instar I.
Length of the c.sk. over 0.5 mm. More than 1 slit in each spiracular plate . . 2.
2. Length of the c.sk. below 1.0 mm. 2 slits in each spiracular plate Instar II.
Length of the c.sk. over 1.9 mm. 3 slits in each spiracular plate. Brown spines. Double rows of macrospines near the frontal margin of the abdominal segments . . . . . Instar III.

The pupa is described briefly.

Literature

ANDERSEN, E. H., 1962. Control of *Dermatobia hominis* in America. *Vet. Rec.* 74: 784—787.

BANEGAS, A. D., H. MOURIER & O. H. GRAHAM, 1967. Laboratory colonization of *Dermatobia hominis* (Diptera: Cuterebridae). *Ann. ent. Soc. Am.* 60: 511—514.

BANEGAS, A. D. & H. MOURIER, 1967. Laboratory observations on the life history and habits of *Dermatobia hominis* (Diptera: Cuterebridae). I. Mating behaviour. *Ann. ent. Soc. Am.* 60: 878—881.

BLANCHARD, R., 1892. Sur les Oestrides américains dont la larve vit dans la peau de l'homme. *Annls Soc. ent. Fr.* 61: 109—154.

BUSHLAND, R. C., 1960. Screw-worm research and eradication. *Adv. Vet. Sci.* 6: 1—18. Academic Press, Inc., New York.

KATIYAR, K. P., F. FERRER & G. MOYA, 1967. Studies on the biology, morphology and sterilization of the tropical warble fly, *Dermatobia hominis* L. Jr. In: The application of nuclear energy to agriculture. *Triennial report (1963—'66) of the Inter-American Institute of Agricultural Sciences of the OAS.* Training and research centra Turrialba, Costa Rica. 84—103.

KNIPLING, E. F., 1955. Possibilities of insect control or eradication through the use of sexually sterile males. *J. econ. Ent.* 48: 459—462.

————, 1964. The potential role of the sterility method for insect population control with special reference to combining this method with conventional methods. Circ. ARS-33-98, USDA, Washington, D. C. 54 p.

KOONE, H. D. & A. D. BANEGAS, 1959. Biology and control of *Dermatobia hominis* in Honduras (Diptera: Cuterebridae). *J. Kans. ent. Soc.* 32: 100-108.

MOURIER, H. & A. D. BANEGAS, 1970. Laboratory observations on the life history and habits of *Dermatobia hominis* (Diptera: Cuterebridae) II. Oviposition, the eggs. *Vidensk. Meddr dansk naturh. Foren.* 133: 59—68.

NEEL, W. W., O. URBINA, E. VIALE & J. DE ALBA, 1955. Ciclo biológico del tórsalo (*Dermatobia hominis* L. Jr.) en Turrialba, Costa Rica. *Turrialba* 5: 91—104.

NEWSTEAD, R. & W. H. POTTS, 1925. Some characteristics of the first stage larva of *Dermatobia hominis* Gmelin. *Ann. trop. Med. Parasit.* 19: 247—260.

RASMUSSEN, S. & J. A. JOBSEN, Attempts to rear tórsalo, *Dermatobia hominis* (Diptera: Cuterebridae) on artificial diet. In manuscript.

THIEL, P. H. VAN, 1924. Over het voorkomen van de larve van *Dermatobia hominis* L. bij den jaguar. Herinneringsboek Inst. Trop. Geneesk., Leiden: 138—152.

TOWNSEND, C. H. T., 1935. Manual of Myiology. Part II, Dermatobia: 228—233. C. Townsend and Filhos, Itaquequecetuba.