

CLASSIFICATION OF THE MAIN MACROSCOPIC LESIONS
PRODUCED BY LARVAE OF *GASTEROPHILUS* SPP.
(DIPTERA:GASTEROPHILIDAE) IN FREE-RANGING HORSES
IN UMBRIA

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ABSTRACT. Listed and described herein are the main macroscopic lesions produced along the whole digestive tract of free-ranging horses by larvae of the five *Gasterophilus* spp., occurring in Umbria, a region of central Italy: *Gasterophilus intestinalis*, *Gasterophilus nasalis*, *Gasterophilus pecorum*, *Gasterophilus inermis*, *Gasterophilus haemorrhoidalis*.

Lesions are classified on the basis of their sizes and shapes and the host's anatomic sites infested, and they are examined in relation to the developmental stages of larvae causing them.

The examination of the lesions shows that it is very difficult to differentiate the hemorrhagic impressions caused by migrating 1st and 2nd instar larvae of all the species in the absence of the specific parasite. It is also difficult to differentiate between the gastric lesions caused by *Gasterophilus intestinalis* and *Gasterophilus pecorum*. It has been found that an easy identification is possible even in the absence of parasites for gum lesions and for lesions on the soft palate produced respectively by *Gasterophilus intestinalis* and *Gasterophilus pecorum*, for duodenal lesions caused by *Gasterophilus nasalis*, for rectal lesions caused by *Gasterophilus inermis* and for duodenal and rectal lesions produced by *Gasterophilus haemorrhoidalis*.

KEY WORDS: *GASTEROPHILUS*; MACROSCOPIC LESIONS

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INTRODUCTION

THE larvae of *Gasterophilus* species infect the digestive tract of horses, and their pathogenic action varies with the species. Pathogenicity depends in part upon the migration and localization of larvae, their morphological structures, the sizes of their mouth hooks, and the reaction of the gastroenteric mucosa to the mechanical stimuli produced by various *Gasterophilus* species.

We have been able to recognize the most common macroscopic lesions, caused by each of the five species of the parasite found in Umbria (3,4,5).

Our aim has been, therefore, to describe and classify these lesions on the basis of their gross pathologic characteristics, in relation to the location in the tract to the species, and developmental stages of *Gasterophilus* larvae, in order to verify the possibility of identifying the infesting parasite even in its absence.

MATERIALS AND METHODS

The whole digestive tracts from 570 free-ranging horses, affected by gasterophiliasis, were systematically inspected over a four year period. Their infested tissues were frozen, with larvae still anchored to them, or kept in plastic bags and glass containers with 10% formalin. Larvae collected were identified according to the keys proposed by Zumpt (1965), Grunin (1969) and Draber Monko (1978), and kept in a solution of 80% alcohol (90 parts) and glacial acetic acid (10 parts).

RESULTS

The macroscopic lesions observed in digestive tracts of free-ranging horses in Umbria were caused by 1st, 2nd and 3rd instar larvae of five *Gasterophilus* species: *Gasterophilus intestinalis*, *Gasterophilus nasalis*, *Gasterophilus inermis*, *Gasterophilus pecorum*, and *Gasterophilus haemorrhoidalis*. On the basis of the diameters of lesions in relation to the developmental stages of larvae and their relative sizes, we have differentiated:

1. *Lesions having very small diameters (0.5-1mm):*
 - Pit-like lesions:* non prominent lesions, the diameters of which are smaller or approximately the same as the ones of a 2nd instar larva, and deep enough to contain half a larva.
 - Nodular lesions:* prominent spherical lesions, as large as a chick-pea, with one to four very small and deep holes, caused by the full penetration of 2nd instar larvae of *Gasterophilus inermis*.

2. Lesions having small diameters (2-3 mm):

- Crater-like lesions*: prominent lesions, the crater diameters of which, being smaller than the ones of a 3rd instar larva, can contain only the pseudocephalus of a larva.
- Atypical pit-like lesions*: non prominent lesions, mainly round-shaped and even-edged. They are rare and are considered as atypical, since they are produced by the clasping of 3rd instar larvae of *Gasterophilus intestinalis* on an already affected mucosa.

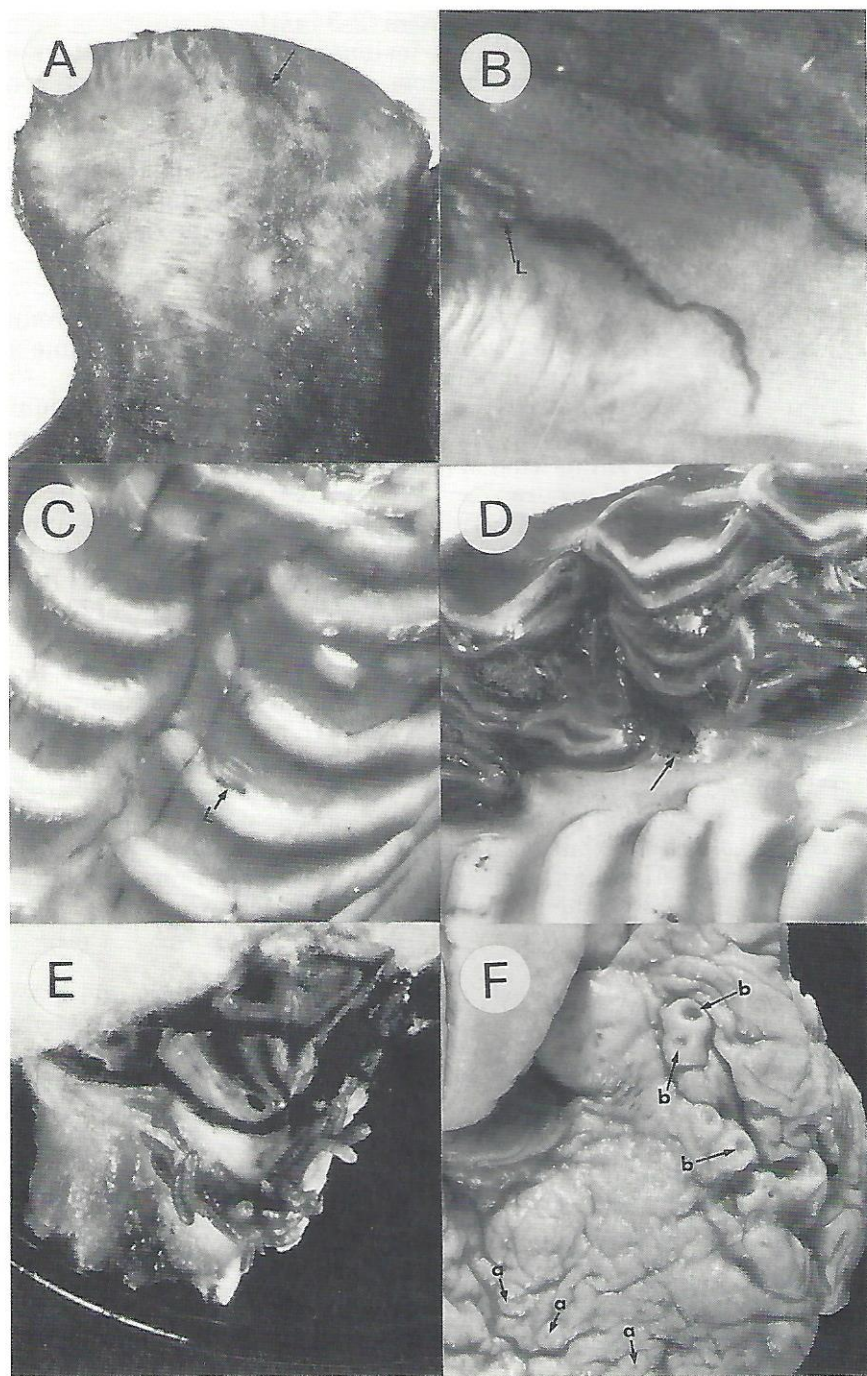
3. Lesions having large diameters (4-5 mm):

- Pit-like lesions*: very deep lesions, occasionally with a small prominence, diameters of which are larger or approximately the same as the ones of a 3rd instar larva of *Gasterophilus inermis*.
- Multiple erosive crater-like lesions*: prominent shallow lesions, caused by the convergency of several lesions having small diameters. The edges of this kind of lesion seldom appear smooth, but are generally rough in nature.
- Funnel-like lesions*: small prominent circular lesions, the inner walls of which sometimes clearly show the impression of a larval body. They are not deep lesions, and clearly narrow at their base. They can contain the first segments of 3rd instar larvae of *Gasterophilus nasalis*.
- Button-like lesions*: prominent lesions, composed of three or four deep holes, surrounded by a thick ring of mucosa. They are caused by the transformation of previous nodular lesion produced by 2nd instar larvae of *Gasterophilus inermis* moulted to the 3rd instar in the same site.

The inspection of the pathologic material available and the comparison of different tissues affected by the five species of *Gasterophilus* have allowed the classification of the main macroscopic lesions in relation to the anatomic location, as follows:

Oral lesions

- Lesions on the lips*: burrows around the mouth corners and below the lip skin, caused by 1st instar larvae of *Gasterophilus inermis* (Pl.1 A).
- Lesions on the mucosa of cheeks, tongue and palate*: superficial burrows, sometimes broken on the upper wall possibly by larval movement in the breathing process. They look like hemorrhagic impressions, variously branched, directed toward the root of the tongue and the soft palate, and become broader as larvae increase in size. These lesions are produced by the migration of 1st and 2nd instar larvae of *Gasterophilus pecorum*, *Gasterophilus inermis* and *Gasterophilus intestinalis* (Pl.1 B and C).
- Hemorrhagic petechial lesions in the mouth mucosa*: very small hemorrhagic petechiae in the mucosa of cheeks and in the edges of



the tongue, caused by the penetration of 1st instar larvae of *Gasterophilus pecorum* or more often, on the tip of the tongue, produced mainly by 1st instar larvae of *Gasterophilus intestinalis*.

- Gum interdental lesions*: they are represented by large holes in the gums, with localization of 1st and 2nd instar larvae of *Gasterophilus intestinalis* (an average of 15-20 larvae per lesion), most commonly found between upper molar teeth. Sometimes, one can observe a sort of larval aggregation room, which, following parasite emergence, may fill with vegetal debris and often with pus result from internal infections (Pl.1 D and E).
- Lesions on the soft palate*: holes having different diameters, produced by 2nd and 3rd instar larvae of *Gasterophilus pecorum*. These lesions can be of two kinds: a) pit-like lesions having very small diameters, caused by the clasping of 2nd instar larvae of *Gasterophilus pecorum* to the mucosa of the soft palate following their emergence from their burrows in the mucosa of the palate and tongue. b) crater-like lesions having small diameters, caused by newly moulted 3rd instar larvae of *Gasterophilus pecorum* (Pl.1 F).

Gastric lesions

- Pit-like gastric lesions having very small diameters*: caused by the clasping or by the partial penetration of 2nd instar larvae of *Gasterophilus intestinalis* and *Gasterophilus haemorrhoidalis* (Pl.2 A).
- Crater-like gastric lesions having small diameters*: in close proximity and often in great numbers, caused by the penetration of 3rd instar larvae of *Gasterophilus pecorum* and *Gasterophilus intestinalis*. In the cases of strong infestations with more than 400 larvae of *Gasterophilus intestinalis*, these lesions were particularly close to each other and gave the gastric mucosa a typical appearance characterized by the thickening of the mucous plicae (Pl.2 B and C).
- Multiple erosive crater-like gastric lesions*: caused by the convergence of several 3rd instar larvae of *Gasterophilus intestinalis* in some regions of the gastric plicae. As a result, characteristic lesions appear having uneven edges, or a crater larger but more shallow than usually found (Pl.2 D).

Fig. 1. (A) Burrow on the mouth corner (arrow) produced by a 1st instar larva of *Gasterophilus inermis*.

(B) Burrows on the lateral margin of the tongue produced by 1st and 2nd instar larvae of *Gasterophilus pecorum* (L = larva).

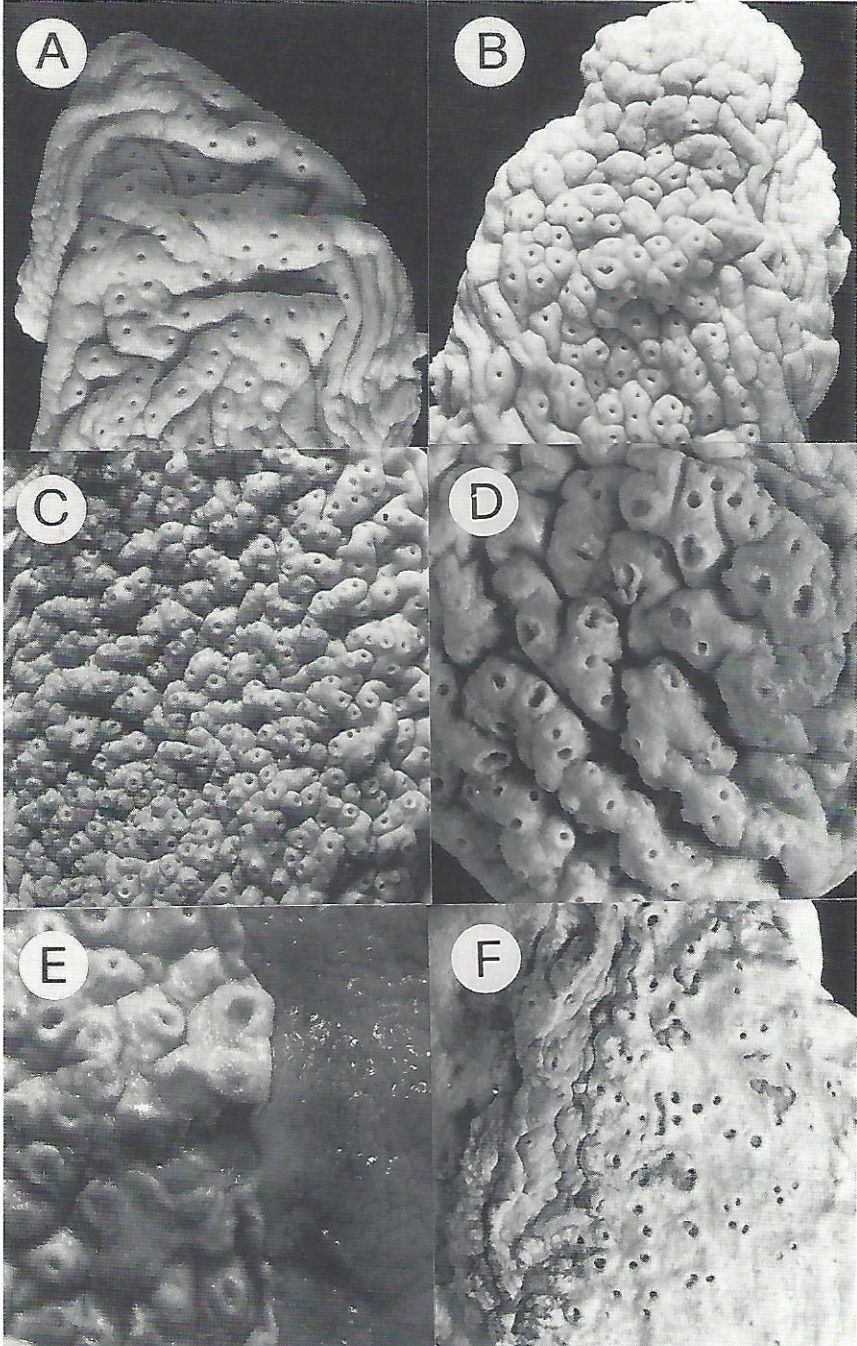
(C) Burrow on the hard palate produced by 1st and 2nd instar larvae of *Gasterophilus pecorum* (L = larva).

(D) Gum hole (arrow) burrowed by 1st instar larvae of *Gasterophilus intestinalis*.

(E) 1st and 2nd instar larvae of *Gasterophilus intestinalis* localized in the interdental spaces.

(F) —Pit-like lesions on the root of the tongue produced by 2nd instar larvae of *Gasterophilus pecorum* (a).

—Crater-like lesions on the soft palate produced by 3rd instar larvae of *Gasterophilus pecorum* (b).



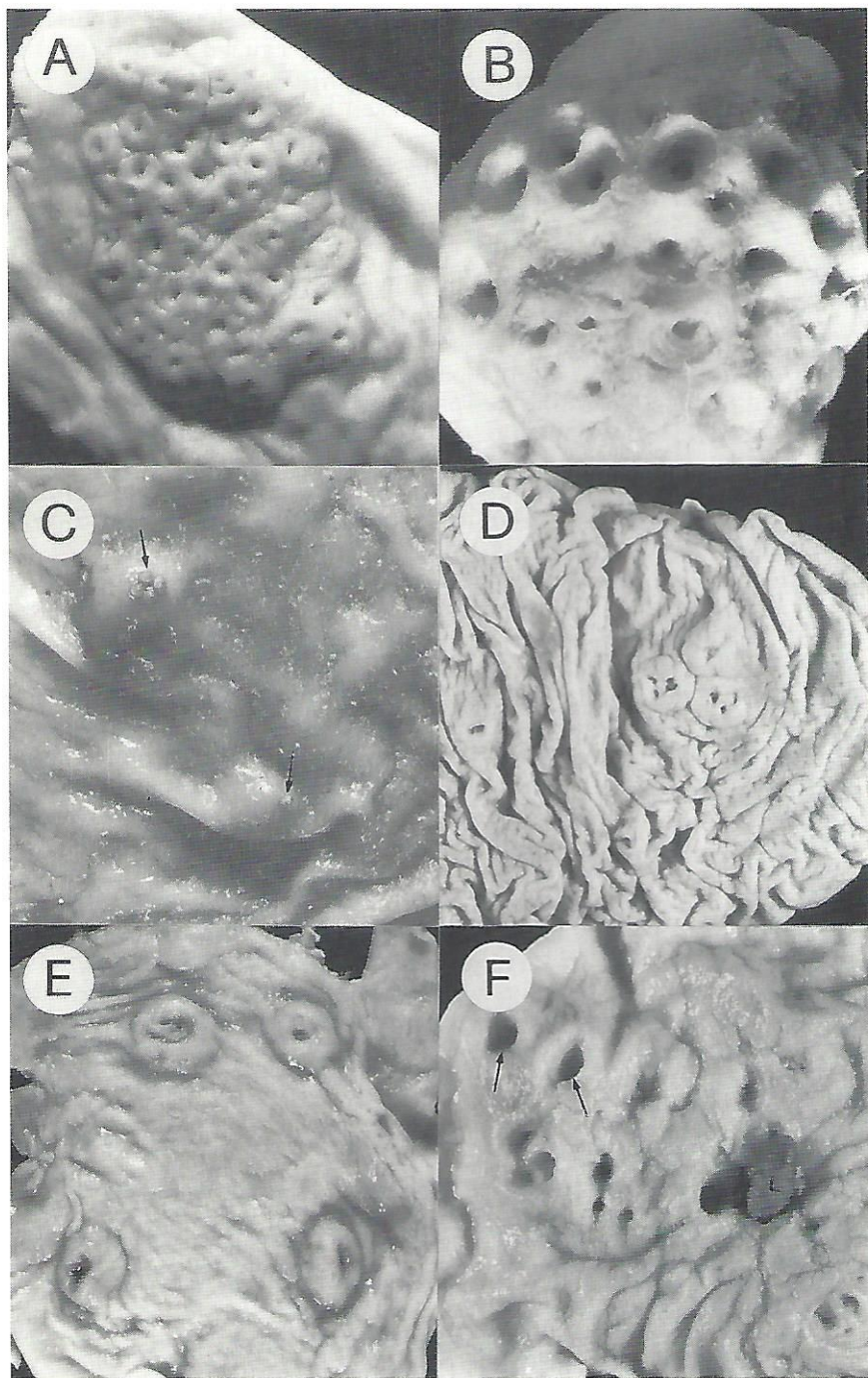
- Erosive gastric lesions*: they result from the detachment of portions of mucosa, sometimes with hemorrhages, caused mainly by the presence of 3rd instar larvae of *Gasterophilus intestinalis* (Pl.2 E).
- Atypical pit-like gastric lesions*: caused by an unusual reaction of the gastric mucosa with 3rd instar larvae of *Gasterophilus intestinalis*, because of the atony and thinning of the muscular and mucous walls of the stomach (Pl.2 F).

Intestinal lesions

- Funnel-like duodenal lesions*: burrowed into the mucosa by 3rd instar larvae of *Gasterophilus nasalis*. These lesions (an average of 50-60), are typically close to each other and, if containing mature 3rd instar larvae, are often separated by slight furrows. The whole of these lesions looks like a prominent button, having a circular or more often an oval shape, up to 6-7 cm long in the dimension (Pl.3 A and B).
- Crater-like duodenal lesions having small diameters*: rare, isolated, prominent lesions, produced by the penetration of 3rd instar larvae of *Gasterophilus haemorrhoidalis*.
- Crater-like lesions along the whole intestine having small diameters*: rare, isolated, slightly prominent lesions, caused by the erratic location of 2nd and 3rd instar larvae of *Gasterophilus intestinalis* and *Gasterophilus nasalis*.
- Nodular rectal lesions*: caused by the full penetration into the mucosa of 2nd instar larvae of *Gasterophilus inermis*. These very small larvae newly moulted to the 2nd instar at the end of their oral migration, immediately reach the rectum and penetrate into its mucosa. Sometimes they are isolated or are in small groups, causing characteristic ulcerated nodules (Pl.3 C).
- Button-like rectal lesions*: originated from the nodular lesions as a consequence of the moulting of small groups of larvae to the 3rd instar. These lesions are typically present in clusters of 3-4 deep holes with a 3rd instar larva of *Gasterophilus inermis* in each one of them. These buttons can be found isolated, or in small groups, often ranged in three horizontal bands, increasing in number as they approach the anus (Pl.3 D and E).

Fig. 2. Lesions in the cardiac region of the stomach produced by *Gasterophilus intestinalis* larvae.

- (A) Pit-like lesions produced by 2nd instar larvae.
- (B) Crater-like lesions produced by 3rd instar larvae.
- (C) Thickening of mucous plicae full of holes caused by strong infestations of 3rd instar larvae.
- (D) Multiple erosive crater-like lesions produced by 3rd instar larvae with a strong thickening of the mucosa.
- (E) Erosive gastric lesions produced by 3rd instar larvae.
- (F) Atypical pit-like lesions produced by 3rd instar larvae.



- Pit-like rectal lesions having large diameters*: originated from the nodular lesions as a consequence of the moulting to the 3rd instar of isolated larvae. These lesions are deep and can contain up to one-half of a 3rd instar larva of *Gasterophilus inermis* (Pl.3 F).
- Crater-like rectal lesions having small diameters*: rare, isolated lesions caused by the clasping of 3rd instar larvae of *Gasterophilus haemorrhoidalis*, prior to evacuation by the animal.

DISCUSSION

It can initially be observed upon examining tissues infested by *Gasterophilus* larvae that there is the convergency of lesions in definite areas of the gastroenteric mucosa. This convergency is due to the instinctive tendency of larvae to gather in specific sites depending on the species.

The knowledge of the life cycle of each species and, therefore, of their specific localizations, helps to identify lesions caused by migrating 1st and 2nd instar larvae. They would otherwise be difficult to identify, as they do not show much difference among them. In most cases, for all the species, the lesions appear as intersecting hemorrhagic burrows, and only when larvae are found in them, is one able to state exactly which species has produced them. As for lesions produced by immature stages, in fact, only few particular cases are easy to identify. For instance, gum lesions produced by 2nd instar larvae of *Gasterophilus intestinalis* are located in the interdental spaces, and lesions on the soft palate are produced, at least in Umbria, only by long-clasping 2nd instar larvae of *Gasterophilus pecorum*, as they moult to the 3rd instar. As for the other species, it appears from our repeated observations (Principato et al. 1985) that, once larvae have changed from the 1st to the 2nd instar, and they have finished their oral migration, they all very soon reach their specific sites of localization. This is supported by the finding of very small 2nd instar larvae in those regions, or by finding pit-like lesions having very small diameters, caused by 2nd instars. Even in the rectal site, very small nodular lesions produced by 2nd instar larvae of *Gasterophilus inermis* may be found.

Fig. 3. (A) Funnel-like duodenal lesions produced by 3rd instar larvae of *Gasterophilus nasalis*.

(B) Duodenal mucosa bent as to show the inner walls of its funnel-like lesions.

(C) Nodular rectal lesions caused by the full penetration of 2nd instar larvae (arrows) of *Gasterophilus inermis*.

(D) Button-like rectal lesions close to each other produced by 3rd instar larvae of *Gasterophilus inermis*.

(E) Button-like rectal lesions isolated produced by 3rd instar larvae of *Gasterophilus inermis*.

(F) Pit-like rectal lesion (arrows) caused by 3rd instar larvae of *Gasterophilus inermis* (L = larva).

Among the typical lesions produced by 3rd instar larvae are: the button-like and pit-like rectal lesions produced by *Gasterophilus inermis* and the funnel-like duodenal lesions produced by *Gasterophilus nasalis* and also the very rare and isolated crater-like lesions produced by *Gasterophilus haemorrhoidalis* in the duodenum and in the rectum.

Lesions produced by 3rd instar larvae of *Gasterophilus intestinalis* are similar to those caused by 3rd instar larvae of *Gasterophilus pecorum*. Massive infestation in the stomach is without doubt caused primarily by *Gasterophilus intestinalis*, not excluding the possible presence of *Gasterophilus pecorum* in small numbers.

It is possible that larvae of all *Gasterophilus* species may produce lesions of a somewhat different nature from those observed in this study. For example the erratic localization of larvae, the different reaction of the gastroenteric mucosa in pathological conditions, the detachment of larvae at the beginning of their clasping due to the mechanical action of the gastroenteric contents, etc., may lead to some variation in the physical nature of the lesions. Nevertheless, it is our opinion that, because of a strict connection between the morphological structure of larvae and the host's mucosa, most of the lesions present characteristics of the kind described by us.

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