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SHORT COMMUNICATION

An isthmus at the caecocolical junction is an anatomical feature of domestic and wild equids

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Abstract The isthmus at the caecocolical junction in domestic equids is well described. Like another isthmus between the ansa proximalis coli (the colonic fermentation chamber or 'large colon') and the colon transversum (the distal or 'small' colon), this spot represents not only a potential anatomical feature contributing to particle ingesta retention but also an explicit predilection site for intestinal obstructions. The question whether this anatomical feature also occurs in wild equids is therefore of both physiological and medical interest but has not been addressed so far. In this paper, we report dissections of the large intestine of a domestic pony (*Equus caballus f. dom.*), a Przewalski horse (*Equus przewalski*) and a plains zebra (*Equus burchelli*). The intestinal tract section of all three animals were similar in length; each species displayed the caecocolical isthmus as well as the abrupt narrowing of the intestinal tract between the 'large' and the 'small' colon. Graphical descriptions of wild equid gastrointestinal anatomy should include these features.

Keywords *Equus caballus* · *Equus ferus* · *Equus przewalski* · *Equus quagga* · *Equus burchelli* · Tapir · Hindgut fermenter · Anatomy · Caecum · Digestion · Colic

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Introduction

In the digestive anatomy of domestic horses, the isthmus between the caecum head and the proximal colon is a well-recognized feature (Sisson et al. 1975; Roger and Cabanie 1991; Budras and Röck 2004; Nickel et al. 2004) that can also be found in numerous older anatomical drawings (for an example, see Fig. 1). This isthmus is considered to contribute to the selective retention of particles in the caecum (Drogoul et al. 2000), where they are submitted to an initial bacterial fermentation, which is then continued as they later pass on into the proximal colon. This isthmus is the reason why domestic horses can suffer from caecal head impaction after excessive intake of insufficiently comminuted particles such as lawnmower grass, and standard surgical techniques have been developed to bypass this isthmus by caecocolical anastomosis in the case of caecal impaction (Rakestraw and Hardy 2006). Therefore, this anatomical feature is of both physiological and medical interest. In particular, it would be interesting to know, for zoo veterinarians and comparative physiologists alike, whether this anatomical feature exists only in domestic horses or also in non-domestic equid species; a complete resemblance of the digestive anatomy of wild and domestic representatives of closely related species or subspecies cannot always be taken for granted (e.g. Uhr 1995).

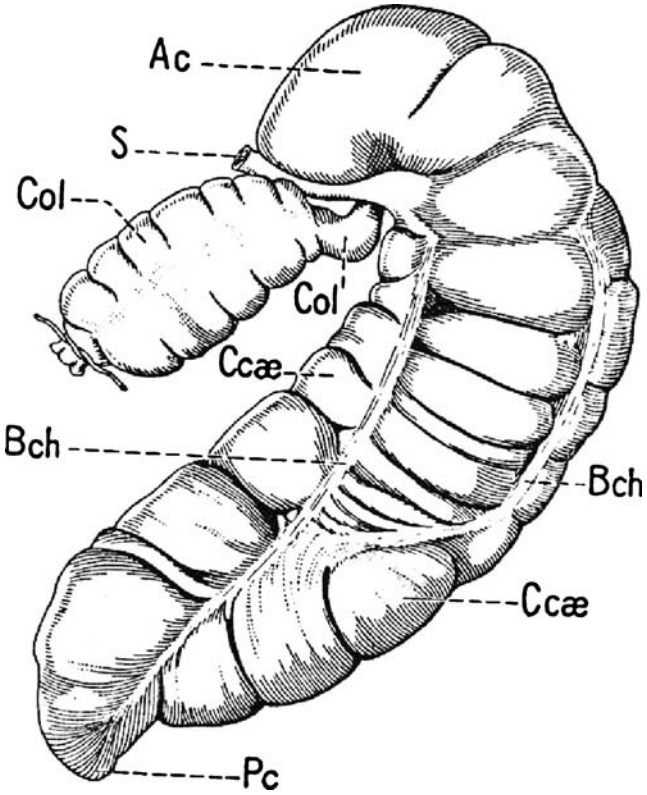

Fig. 1 Graphical representation of the ileum (*S*), caecum head (*Ac*) and the beginning of the proximal colon (*Col*) in the domestic horse from Bourdelle (1955). Note the isthmus between the caecum head and the proximal colon

The graphical description of the intestinal tract of domestic and wild equids (a pony and a zebra) in the standard textbook on comparative vertebrate gastrointestinal anatomy and physiology (Stevens and Hume 1995) does not display this isthmus (Fig. 2). The resulting question is: Was this anatomical feature neglected for both species or does it actually not exist in wild equids? Given the available anatomical literature, it seems difficult to address this question. The only graphical description of the gastrointestinal tract (again, a zebra) in which the location in question is depicted in detail is from Decker et al. (1975). On the one hand, the graphic suggests that an isthmus between the caecum and the proximal colon exists; on the other hand, the faulty positioning of the ileum in that picture draws its validity into question. In older anatomical works (Home 1814; Flower 1872; Mitchell 1903–1906), neither textual nor unequivocal graphical information regarding this anatomical feature could be found.

To address the issue whether the isthmus between the caecum head and the proximal colon is a general feature of equids, we dissected the gastrointestinal tracts of a domestic horse and two wild equids with special focus on the anatomy of the caecal head and proximal colon.

Materials and methods

The gastrointestinal tract of an adult domestic pony (*Equus caballus f. dom.*) was obtained from a slaughterhouse; the body mass of the animal was unknown. A Przewalski horse

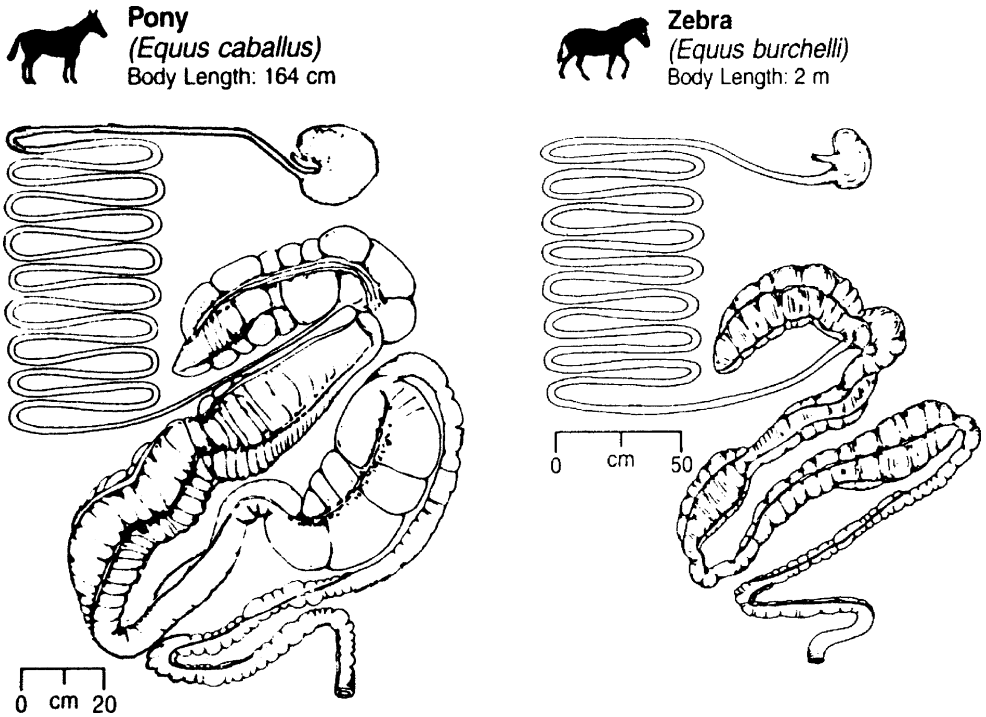

Fig. 2 Gastrointestinal tract of a domestic horse and a zebra from Stevens and Hume (1995). Note the absence of an isthmus between the caecum and the proximal colon

(*Equus przewalski* Poliakov 1881; in the literature, several different scientific names are available for this horse; *Equus ferus przewalski* can also be found, and Wilson and Reeder [2005] recommend the use of *Equus caballus f. fer.* for Przewalski horses; this discussion shall not be investigated here) had been euthanized at a wild animal park for clinical signs of extreme laminitis; at dissection, it weighed 252 kg. A plains zebra (*Equus burchelli* Gray 1824; Groves and Bell [2004] recently reviewed zebra taxonomy and renamed this species *Equus quagga*, a change not adopted by Wilson and Reeder [2005]; this discussion shall not be investigated here) had been euthanized at a zoological institution when an ataxia developed after collision with a tree proved unresponsive to treatment and weighed 264 kg at dissection. The gastrointestinal tracts of all three animals were separated from their mesenteria, and length measurements were taken of the stomach, the small intestine, the caecum, the proximal colon and the rest of the large intestine. Special attention was given to the position and size of the structures leading to and from the caecum head.

Results

The length measurements of the different intestinal segments are given in Table 1. There was no striking difference in the absolute lengths or proportions between the three investigated equids. In particular, the domestic pony did not display a longer small intestine or a shorter large intestine than the two wild equids (the small intestine represented 68–69% of the total intestinal tract length in all species). Compared to the wild equids, the caecum and ansa proximalis coli represented a slightly lower proportion of the total intestinal tract length in the domestic horse (pony: caecum, 4% and ansa proximalis coli, 13%; Przewalski horse: 4 and 14%; zebra: 5 and 16%); instead, the distal colon represented a higher proportion in the domestic horse (pony, 15%; Przewalski horse, 12%; zebra, 11%).

In all three specimens, there was a clearly identifiable isthmus between the caecum head and the proximal colon that had, in each specimen, approximately the same width as the ileum (Table 1, Fig. 3). All three specimens also had the abrupt transition from the 'stomach-like distension' of the proximal colon to the narrow colon transversum (Fig. 4).

Discussion

The findings suggest that the described isthmus between the caecum head and the proximal colon is a general feature of the equid intestinal tract. The graphical description of the wild equid digestive tract should, therefore, be corrected to include this particular characteristic (Fig. 5). Ideally, this feature should also be described in species of wild and domestic donkeys. Thus, the lower equid digestive tract is characterised by two points where the large intestine narrows to such an extent as to form a distinct impediment to immediate digesta passage—at the caecocolonic junction and at the transition from the proximal colon to the colon transversum. The fact that the latter feature occurs in equids but not in larger hindgut fermenters, such as rhinoceroses and elephants, has already been commented upon earlier (Clauss et al. 2003). Similarly, the caecocolical junction is also not marked by a narrowing of the large intestine in rhinoceroses (Stevens and Hume 1995; Clauss, personal observation) or elephants (Clauss et al. 2007). In this respect, it would be especially interesting to have a detailed description of the digestive anatomy of the last group of perissodactyls, the tapirs (*Tapirus* spp.). To our knowledge, no recent description of the digestive anatomy of tapirs exists. Graphical representations from different older sources appear equivocal (Home 1814; Bourdelle 1955), although the drawing by Mitchell (1903–1906) appears to suggest that both narrowings of the large intestine might occur in tapirs as well. It is tempting to speculate that these particular features endow equids and tapirs with the possibility to more efficiently retain ingesta for a more thorough fermentative digestion. The relative anatomical positions of the ileo-caecal valve and the caecocolical isthmus ensure that any ingesta that enters the caecum is most probably thoroughly mixed with the already present

Table 1 Measurements (in cm) of the gastrointestinal tract of three individuals of different equid species

	Equus caballus f. dom.	*Equus przewalski*	*Equus quagga* (*burchelli*)
Length			
Small intestine	1,401	1,478	1,448
Caecum	85	92	106
Ansa proximalis coli	279	306	338
Distal colon and rectum	311	261	225
Width			
Ileum	5	5	6
Caecocolical isthmus	5	5	6

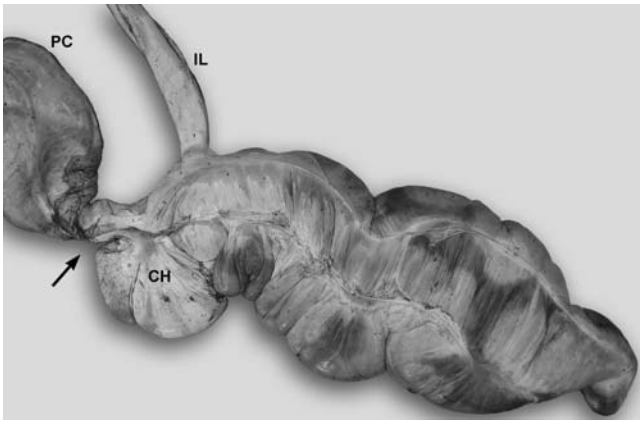

Fig. 3 Ileum (*IL*), caecum and the beginning of the proximal colon (*PC*) of a Przewalski horse (*Equus przewalski*). Note the isthmus (*arrow*) between the caecum head (*CH*) and the proximal colon

caecum contents, rather than passing on into the colon right away. In the case of the rhinoceroses or elephants, no anatomical feature would prevent a theoretical, direct flow of ingesta from the ileum to the colon. However, an actual proof of this assumed function would require detailed studies on ingesta movements in intact horses and horses

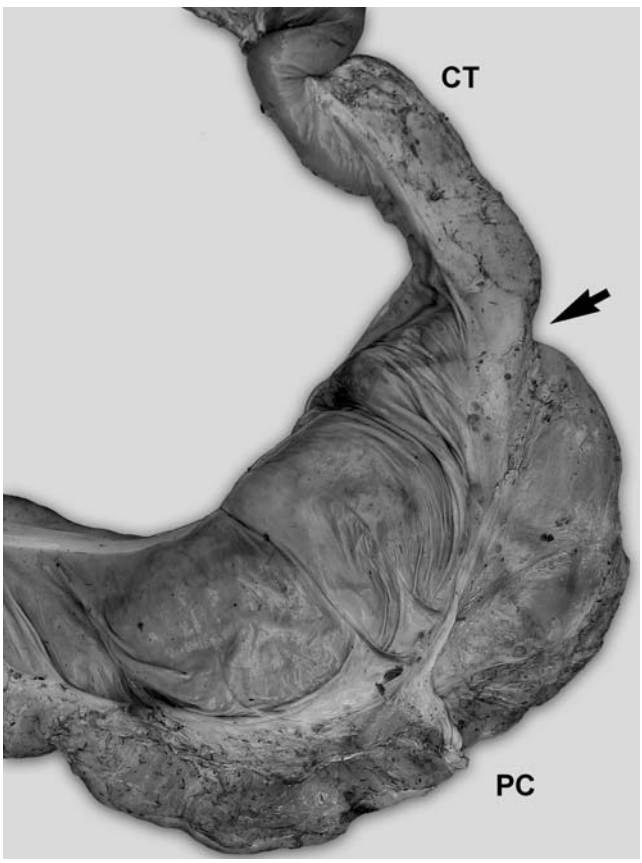

Fig. 4 The abrupt transition (*arrow*) from the proximal colon (*PC*) to the colon transversum (*CT*), typical for equids, in a Przewalski horse (*Equus przewalski*)

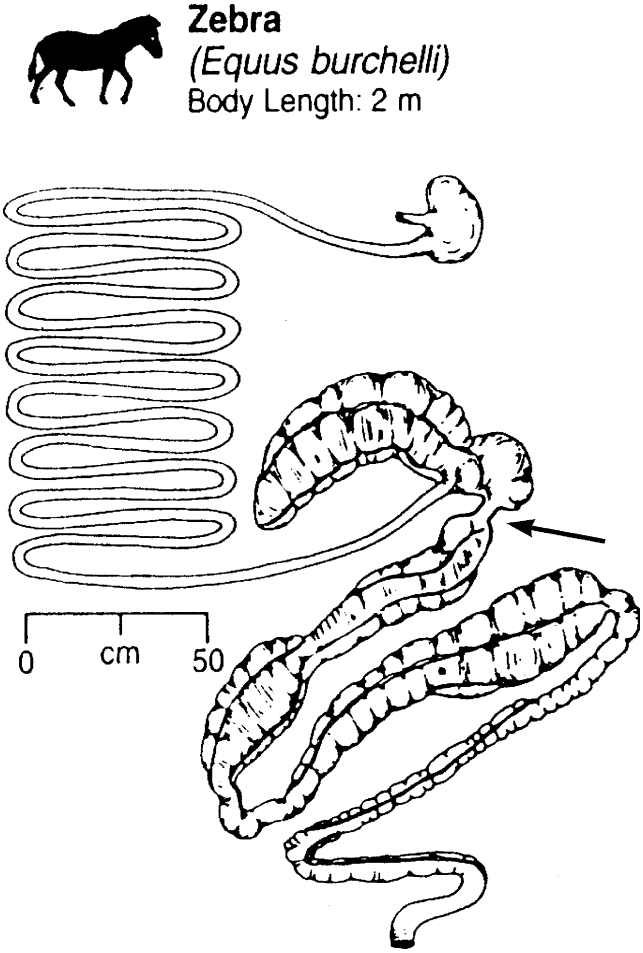

Fig. 5 'Corrected' version of the zebra gastrointestinal tract based on Stevens and Hume (1995); the isthmus between the caecum head and the colon is represented in this drawing (*arrow*)

with a caecocolical anastomosis or at least elaborate computer engineering models.

With respect to veterinary medicine, the relevance of the two narrow points is well known. In particular, the transition from the 'large colon' into the 'small colon' is known to be a predilection site for obstructions or even ruptures of the intestinal wall, for example in the case of enterolith distention (Decker et al. 1975), but rupture as a consequence of impaction also occurs in the caecum in domestic horses (Campbell et al. 1984). In the view of the occurrence of the two described obstruction predilection sites in the equid and supposedly the tapir lower digestive tract, the observation of a high incidence of intestinal problems with no infectious involvement ('colical') in captive wild equids (Ippen and Henne 1991) but also in captive tapirs (Janssen et al. 1996) appears understandable.

As a side observation, the measurements performed in this study (Table 1) do not indicate a particularly longer small intestine in the domestic as compared to the two wild equid species, in contrast to a suspicion stated by Clauss et al. (2003). More quantitative information would be

needed to address this question and the suspicion that wild equids might have slightly longer intestinal sections where microbial fermentation takes place.

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