

## SUSCEPTIBILITY OF CAPYBARA (*Hydrochoerus hydrochoeris hydrochoeris*) TO FOOT-AND-MOUTH DISEASE VIRUS

Félix J. Rosenberg\*; Ivo Gomes\*

### SUMMARY

Eight capybaras (*Hydrochoerus hydrochoeris hydrochoeris*) were exposed by the intramuscular route of foot-and-mouth disease virus (FMDV) type O<sub>1</sub>. Virus was isolated from most of the organs collected from four animals slaughtered 24 to 48 hours post-inoculation (PI). The remaining capybaras developed vesicular lesions in their feet between 72 and 96 hours PI. Virus was shed with feces until at least 10 days PI. Neutralizing and VIA antibodies were developed.

Further contact studies between capybaras and cattle are suggested not only because of the positive results obtained but also because of the high capybara population density in areas considered to be endemic to FMD where a close contact with cattle can be observed.

### INTRODUCTION

One of the most critical and as yet unsolved epidemiological problems in foot-and-mouth disease (FMD) is the survival of the virus in the field during interepidemic intervals. Although carrier cattle are suspected as being responsible for the persistence of the disease in endemic areas, certain observations would indicate that various species of wild animals, particularly rodents, may also act as ecologic reservoirs of the FMD causal agents (1).

Several authors have demonstrated the susceptibility of small wild mammals to FMD in both natural field conditions, as shown for the hedgehog (*Erinaceus europeus*) (2), and by various experimental inoculation routes. The latter include the brown rat (*Rattus norvegicus*) (3), the coypu (*Myocastor coypus*), the mole (*Talpa europaea*), grey squirrel (*Sciurus carolinensis*) and water vole

(*Arvicola amphibijs amphibijs*) (4,5), the armadillo (*Chaetophractus villosus*) (6) and the agouti (*Dasyprocta aguti*) (7). However, in none of these experiments was it possible to indicate whether these species may be considered as actual natural virus reservoirs, whether they play an important role in dissemination of the disease during epidemic outbreaks in domestic animals or if they only constitute an accidental host in the virus cycle.

Of all commonly distributed small wild mammals in South America, the capybara or "water pig" (*Hydrochoerus hydrochoeris*) merits special attention. This species is widely distributed particularly in FMD endemic areas where it maintains a high degree of ecological competition with cattle (8).

No previous experimental data are available relating capybaras to FMD. The present study was designed to determine the susceptibility of this species when exposed to the virus by the parental and systemic route.

### MATERIALS AND METHODS

#### Experimental animals

Seven young (12-20 kg) and one adult (35-45 kg) capybaras were used. They were captured in the municipality of Presidente Prudente, state of São Paulo, Brazil, and donated to the Pan-American Foot-and-Mouth Disease Center (PAFMDC) by the FMD campaign service in that state. All tests were performed in adapted swine boxes with cement floors at the PAFMDC (Pictures 1 and 2).

#### Exposure routes and virus

The animals were inoculated intramuscularly in the leg with 6 ml of a virus suspension containing

\* Pan American Foot-and-Mouth Disease Center, Caixa Postal 589, ZC-00, Rio de Janeiro, RJ, Brazil.

$10^{7.36}$  TCID<sub>50</sub>/ml. The virus strain used was O<sub>1</sub> Campos.

#### Sample collection and clinical examinations

The inoculated capybaras were examined daily to detect the appearance of vesicular lesions in the mouth and feet. Two animals were slaughtered at 24 hrs and two others at 48 hrs post-inoculation (PI). Blood and organ specimens for virus isolation trials were collected from these animals.

Of the remaining 4 animals feces were collected at 4, 5, 6 and 10 days PI.

Organ and feces samples were maintained at -70°C in Vallée medium with antibiotics until used.

For antibody studies blood samples were obtained by cardiac puncture or from the safena vein at 0, 15, 37 and 69 days PI. Sera were kept at -20°C until tested.

#### Virus isolation trials

Heparinized blood samples were inoculated intraperitoneally in newborn mice and IB-RS-2 (9) cell monolayers.

For virus isolation assays from organs and feces, the specimens were suspended in 10 parts (weight/volume) of Earle medium with antibiotics and mixed in a Sorvall\* omnimixer with the addition of seven parts of trichloro trifluorethane (TTE).

The suspensions were centrifuged at 800 g for 30 minutes. Two tenths of ml of the supernatants from the organ suspensions were inoculated onto IB-RS-2 cell monolayers in semisolid medium. Ten ml of the feces supernatants were inoculated into Roux bottles containing IB-RS-2 cell monolayers in liquid media.

#### Serum antibody assays

Agar double diffusion tests were used for the detection of VIA antibodies (10) and the microneutralization test (11) for the titration of specific antibodies.

\* Dupont Co. Inst. Prod. Div. Sorvall Operations, Newtown, Conn. 06470 U.S.A.

## RESULTS

#### Clinical lesions

None of the 4 animals slaughtered at 24 and 48 hrs PI developed macroscopic lesions. However, all the remaining capybaras developed serious vesicular lesions in their 4 feet between 72 and 96 hrs PI (Pictures 3 and 4). These lesions involved all of the interdigital mucosa and were similar to the vesicular lesions produced by FMD in swine. No lesions were observed in tongue, lips or gums. Virus O<sub>1</sub> was isolated from all vesicular lesions.

Three capybaras died between 13 and 38 days PI, presumably because of handling accidents.

#### Virus titration in organs

Virus titers of organ specimens obtained from the 4 capybaras killed at 24 and 48 hrs are shown on Table 1. Virus was detected in most of the organ extracts. In general, virus was isolated more often and virus titers were higher from the animals slaughtered at 48 hrs than from those slaughtered at 24 hrs PI.

#### Virus isolation from feces

Table 2 shows the results of the feces suspensions inoculated onto tissue cultures.

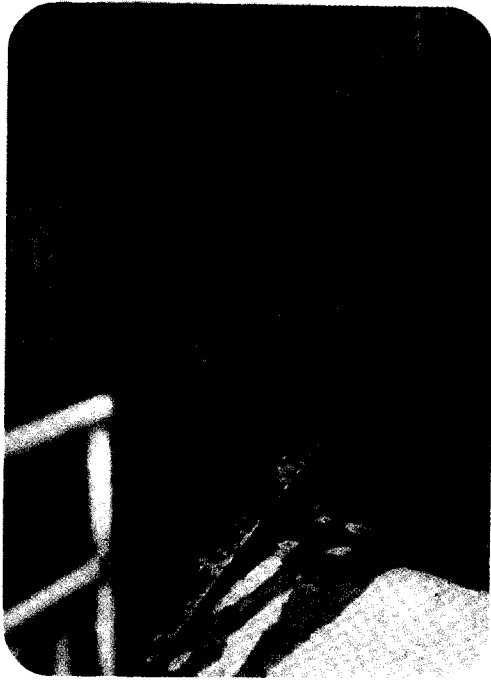
Virus O<sub>1</sub> was isolated from at least one sample of each of the 4 capybaras. In two animals virus was recovered for up to 10 days PI.

#### Development of antibodies

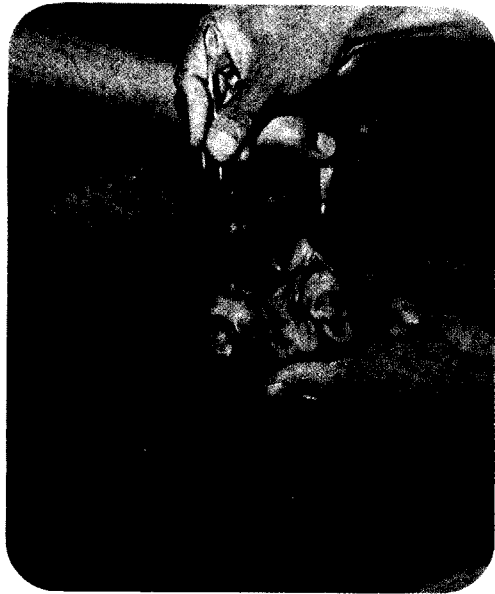
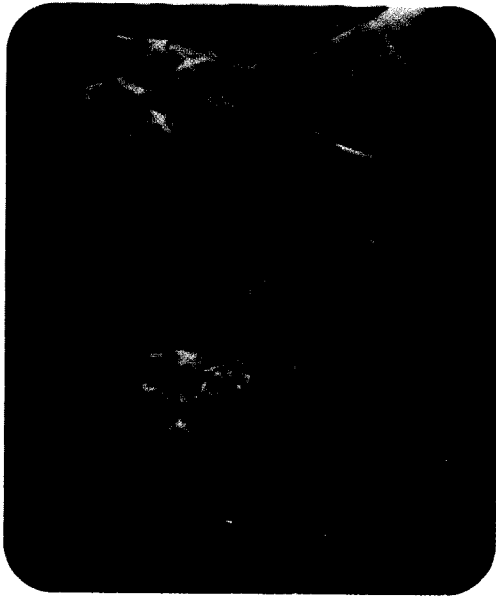
None of the 8 capybaras had detectable antibodies in their sera before virus exposure. The 3 surviving animals developed neutralizing and VIA antibodies between 15 and 37 days PI (Table 3).

## DISCUSSION

This preliminary study has shown that FMD virus inoculated into capybaras by the systemic route actively replicates in several organs, producing generalized vesicular lesions in the feet



*PICTURES 1 and 2. Three of the capybaras used in this study (one adult and 2 young) at the PAMFDC premises.*



*PICTURES 3 and 4. Vesicular lesions characteristic of FMD at the interdigital space of capybaras inoculated intramuscularly 96 hrs before with FMDV O<sub>1</sub>.*

TABLE 1. *Virus isolation from organs of capybaras inoculated intramuscularly, with foot-and-mouth disease virus type O<sub>1</sub> Campos*

Specimen	Hours post-inoculation			
	24		48	
	Animal No. 1	Animal No. 2	Animal No. 3	Animal No. 4
Blood (mice)	3/8*	7/8	8/8	7/8
Blood (IB-RS-2)	—	—	3.3**	—
Farinx	1.7***	—	3.0	1.7
Larinx	—	2.0	2.5	—
Lung	—	—	3.4	1.7
Duodenum	1.7	2.0	1.7	1.7
Colon	1.7	1.7	2.3	2.0
Rectum	2.0	1.7	2.5	2.0
Liver	—	—	2.5	1.7
Pancreas	2.3	2.3	2.8	2.0
Kidney	—	2.0	3.0	2.0
Urinary bladder	2.2	—	2.2	2.0
Sublingual gland	1.7	—	2.9	2.0
Spleen	—	2.0	2.5	—
Retropharyngeal lymphnode	—	2.0	3.2	1.7
Mediastinic lymphnode	1.7	1.7	2.0	1.7
Inguinal lymphnode <sup>1/</sup>	3.5	2.0	4.6	2.8
Inoculated muscle	2.6	3.3	2.4	NT
Heart	1.7	—	—	2.3

<sup>1/</sup> The lymphnode corresponds to the inoculated leg in animals 1, 3 and 4 and to the opposite leg in animal 2.

\* Number of death/total inoculated.

\*\* Log ID<sub>50</sub>%/ml of blood.

\*\*\* Log PFU/g.

NT Not tested.

— Negative.

TABLE 2. *Virus isolation from feces of capybaras inoculated intramuscularly with foot-and-mouth disease virus type O<sub>1</sub> Campos*

Animal No.	Days post-inoculation			
	4	5	6	10
5	—	+	—	+
6	+	+	+	+
7	NT	NT	+	—
8	+	+	+	—

+ Positive.

— Negative.

NT Not tested.

similar to the lesions observed in domestic susceptible animals when infected naturally by FMD. The relatively high virus titers obtained from the inguinal lymph nodes corresponding to the inoculated leg indicate that this is presumably the primary virus replication site.

The susceptibility of various small wild mammals exposed by different routes to FMD virus has been already demonstrated. Special reference must be made to the hedgehog, which is apparently susceptible to natural field infection (2). Other species which might become infected by contact and/or food exposure include the brown rat (3), the coypu (4), squirrel (5), armadillo (6) and agouti (7).

Of all these wild species the capybaras merit special attention. Capybaras share common habitats with cattle, particularly in flooded areas, where they share scarce dry sleeping places at night, as indicated by the large amounts of cattle and capybara feces observed at those places. The extensive flooded areas existing in South America are as well a characteristic of the endemic FMD ecosystems considered to be virus reservoirs in the southern part of the continent (i.e. Paraguayan Chaco, Paraguay; Mato Grosso's Pantanal, Brazil; the province of Entre Ríos, Argentina, and the eastern plains of Colombia (12).

The susceptibility of capybaras to the intramuscular inoculation of this FMD virus strain does not necessarily mean that this species constitutes an actual virus reservoir. On the contrary it might well be a secondary host to virus transmitted by cattle, in which case its epidemiological interest would not exceed that of an occasional virus transmitter during acute outbreaks.

The results obtained in the present study in relation to the susceptibility of capybaras to FMD virus, the close contact existing between capybaras and cattle in the field and the characteristic distribution of this species in areas suspected to be endemic for FMD, suggest the need for the development of contact studies between capybaras and with susceptible domestic species, particularly cattle, as well as the investigation of virus persistence in infected animals and field studies to determine FMD infection prevalence rates in capybaras of endemic areas.

TABLE 3. *Microneutralization and VIA antibody development in capybaras inoculated intramuscularly with foot-and-mouth disease virus type O<sub>1</sub> Campos*

Animal No.	Days post-inoculation							
	0		15		37		69	
	MN <sup>1</sup>	VIA <sup>2</sup>	MN	VIA	MN	VIA	MN	VIA
5*	<1.0	-	1.65	-	2.7	+		
6*	<1.0	-						
7*	<1.0	-	1.8	+				
8	<1.0	-	2.25	+	2.55	+	2.4	+

1. Microneutralization = Reciprocal of the logarithm of the dilution neutralizing 100-200 ID<sub>50</sub>.

2. - = Negative; + = Positive.

\* Animal No. 5 died 38 days PI; No. 6 died 13 days PI; No. 7 died 22 days PI.

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