

*Istituto Zooprofilattico Sperimentale dell' Abruzzo e del Molise
«G. Caporale» — 64100 Teramo, Italy
Istituto di Malattie Infettive — Facoltà di Medicina Veterinaria
40100 Bologna, Italy*

Epidemiology of Dourine in the Equine Population of the Abruzzi Region¹

By

V. P. CAPORALE, G. BATTELLI and GIOVANNA SEMPRONI

With 3 figures and 2 tables

(Received for publication March 17, 1980)

Introduction

Dourine is a disease of solipeds caused by *Trypanosoma equiperdum*. It is considered to be transmitted almost exclusively by coitus (PARKIN, 1948). After an epidemic which spread throughout Europe soon after World War II (GRATZL, 1946; DOMANSKI, 1949; KALUSCH, 1949; KALKIN, 1950), it disappeared from Western Europe. No case was recorded in Italy after 1950 (BAREI and BINAGHI, 1947; TOMASONI, 1948; Anon., 1975), until a clinical case of the disease was reported in a stallion of a private stud in Tagliacozzo (Abruzzi Region, Italy) in August 1975.

In 1975 dourine was reported in the Mediterranean area, in the Syrian Arab Republic, in Morocco, Algeria, and probably in the Libyan Arab Republic (Anon., 1975). It was also present in USSR, Ethiopia, Senegal, Botswana, Lesotho, Republic of South Africa, Saudi Arabia, Nepal, Lao PDR (Anon., 1975), and probably in Iran (KHALILI, 1973; Anon., 1975). An enquiry indicated that the disease might be present in several zones of the Abruzzi Region and a survey was carried out from September 1975 to March 1976 in order to: 1. identify the geographical limit of the epidemic; 2. ascertain the prevalence of the infection in the soliped population of the affected area; and 3. study the dynamics of the epidemic. The results of the survey are reported in this paper.

Material and Methods

1. Area description

The epidemiological survey was carried out within 20 Municipalities (Communes) of the Abruzzi Region (Figure 1). Zone A is separated from Zone B by mountain ranges of over 1,829 m. The only connection existing between them is a narrow upland plain (Zone C).

¹ The research was carried out with a grant of the Direzione dei Servizi Veterinari of the Ministry of Health, Rome, Italy.

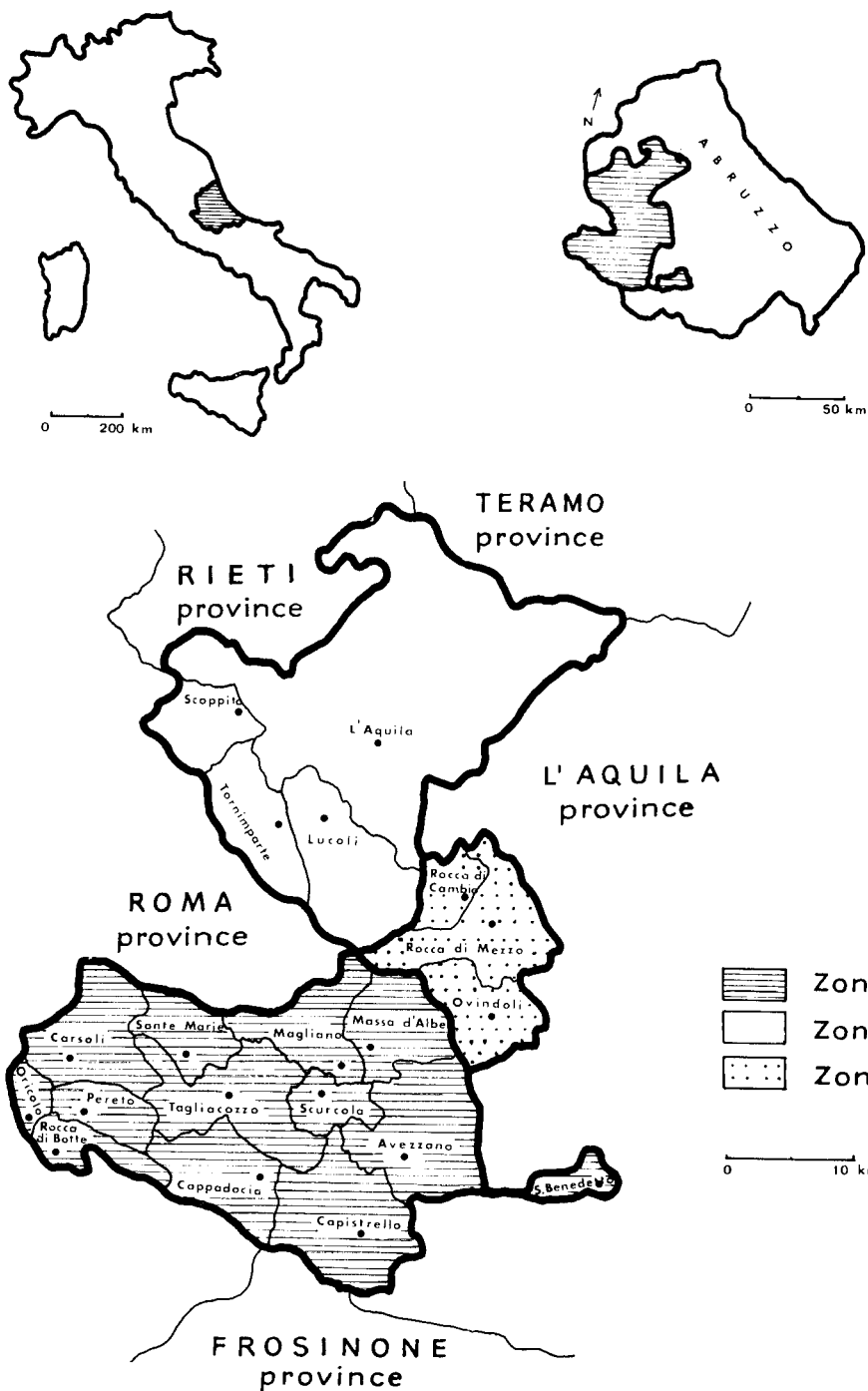


Fig. 1. Map of the territory where the survey was carried out showing the location of the municipalities and the confines of each zone

Zone A borders with Rome and Frosinone Provinces (Lazio Region) and Zone B borders with Rome and Rieti Provinces (Lazio Region) and Teramo Province (Abruzzi Region).

The Eastern boundary of Zone A is the Fucino lowland, for Zone B the Gran Sasso mountain range (1,829 to 2,743 m.) and for Zone C the Sirente range (1,372 to 2,134 m.).

Horses are kept on pastures belonging to the different municipalities and lying at between 610 and 1,219 m. altitude. There is no separation between pastures belonging to the different municipalities other than natural barriers, such as rivers, higher ranges, roads, etc.

2. Epidemiological data collection and analysis

In the municipalities the survey was carried out by "down the road testing" (SCHWABE, 1977). For each of the 4,799 animals tested a form was completed at the time of the blood sample collection.

Data storage and analysis were carried out with an Olivetti P 6060 computer. A specific software (SOMOCO) was developed by the authors for the handling of data.

3. Equine population

4,799 solipeds (2,841 horses and 1,958 asses) were examined.

The distribution of the horse population was as follows: 1,796 (63.2%) in Zone A; 884 (31.1%) in Zone B and 161 (5.7%) in Zone C.

The average population density was about 5, 1, and 3 horses per square km. in Zones A, B and C, respectively. The percentage of the total samples tested in each municipality

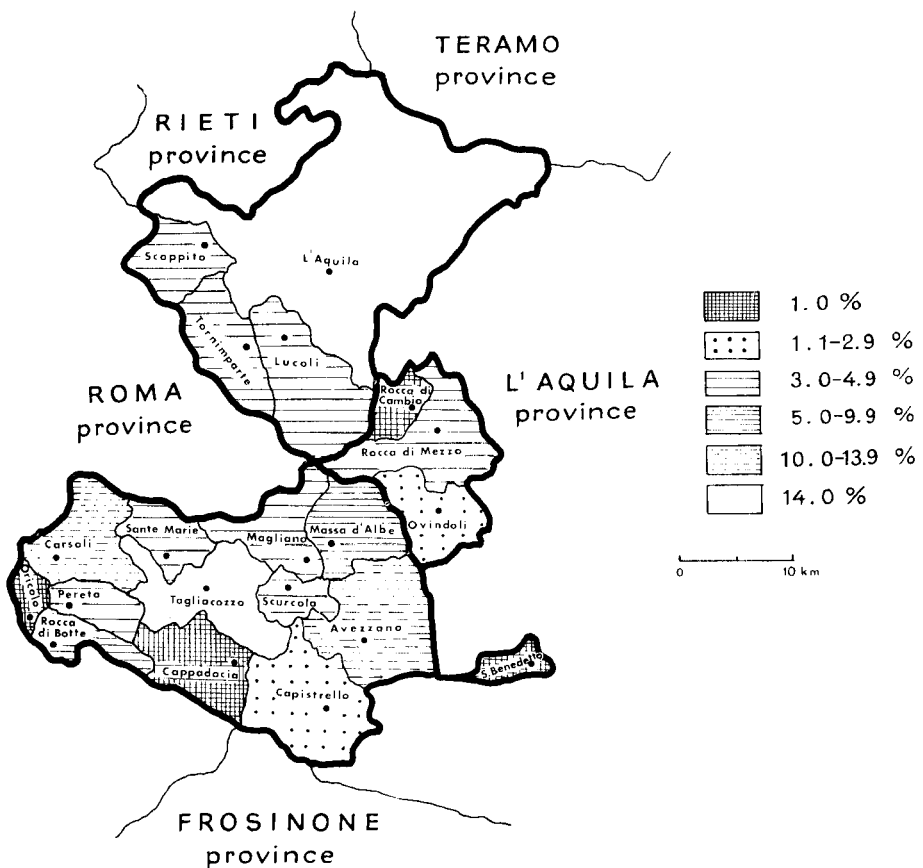


Fig. 2. Map showing the percentage of the horse population of each municipality tested by the c. f. test

is shown in Figure 2. The sample may virtually represent the whole population existing in the territory, since it was 50% higher than the official equine population based on official counts; this rather large discrepancy may result from the custom of concealing horse ownership from census takers for fiscal reasons.

The majority of horses, apart from those of the municipality of Avezzano, are kept on open mountain ranges which lie in the outskirts of villages. Animals are seldom inspected by their owners and the inspection, when practised, is carried out at a distance. Horses are mainly raised for meat production; some are also used in the summer months as saddle horses for tourists. Under Italian law authorization by agriculture and veterinary officials is required to keep sexually mature stallions. On the basis of the collected data only 18.7% of the stallions were authorized for public and private stud. The remainder (81.3%) were unauthorized and kept constantly with females on the range and were therefore not controlled from the sanitary point of view.

Breeding is seasonal and starts at the end of March; it reaches its peak in May and June, then declines and almost ceases at the end of August. Virtually all asses are kept in stables and used only for transportation of men and goods. The majority of she-asses are bred to horse stallions to obtain mules.

Animal movements are rather intensive, both through markets and direct transactions. Equines are frequently bought in the markets of Rome and Modena, as well as from nomadic dealers. There is virtually no sanitary control at this level.

4. Serology

Blood samples were taken from each horse three times at 20 day-intervals and the sera tested by complement fixation (CF) according to the techniques described by CAPORALE et al. (1977) for *Trypanosoma equiperdum* antibody.

Results

The results of the serological tests are reported in Table 1. Of the 2,841 horses tested, a total of 210 were positive (7.4%) comprising 18.1% of the stallions, 4.5% of sexually immature male horses², 6.6% of geldings, 6.8% of the mares, and 5.4% of sexually immature females.

Twenty six (1.3%) of the 1,958 asses tested were positive, all of them females bred to horse stallions. Statistical analysis was restricted to the data concerning the horse population because (1) the low level of positive reactions in the ass population did not allow a statistically significant evaluation and (2) the ass population did not seem to be significant in the spread of the epidemic (see Discussion).

In Table 2 the infection prevalence rates encountered in each municipality are reported. They were not homogeneous in all municipalities. The prevalence rate of the whole population (7.4%) was compared with the rate of each municipality by statistical analysis (relative risk [R_e]). On the basis of the results, the municipalities were divided into High Risk Municipalities (HRM); Average Risk Municipalities (ARM); Low Risk Municipalities (LRM), and Negative Municipalities (NM) (Figure 3).

Figure 3 shows that the population of Zone B was free from infection. In Zone C infection in Ovindoli Municipality was restricted to one herd of a horse dealer; in the Rocca di Mezzo Municipality to the mares served either in a positive stud or by one stallion brought to Zone C from Zone A; in the Rocca di Cambio Municipality to one female brought for service to a positive stallion in the Rocca di Mezzo Municipality.

A total of 155 stallions were examined; only 29 were authorized (AS) and 126 unauthorized (US). Seven authorized stallions and 21 unauthorized were positive, with an overall prevalence rate of 18.1% (Table 1). The prevalence rates were 24.1% among the AS and 16.7% among the US.

² Horses under 8-months of age are classified as sexually immature.

Table 1

Results of serological test for *Trypanosoma equiperdum* antibody carried out in the equine population of 20 municipalities of the Abruzzi Region, 1975—1976

Animal categories	No. of Horses		No. of Donkeys	
	Tested	Positive	Tested	Positive
STALLIONS				
Authorized	29	7	15	none
Unauthorized	126	21	none	none
MARES				
Serviced by authorized stallions	703	57	1919	26
Serviced by unauthorized stallions	1324	114	none	none
Unknown service	495	none	none	none
SEXUALLY IMMATURE MALES	22	1	1	none
SEXUALLY IMMATURE FEMALES	37	2	5	none
GELDINGS	105	8	18	none
TOTALS	2841	210	1958	26

Table 2

Results of serological tests for *Trypanosoma equiperdum* antibody carried out on the horses of 20 municipalities of the Abruzzi Region

Municipality	No. of horses	
	tested	positive
Scoppito	91	none
Lucoli	130	none
Ovindoli	37	21
Rocca di C.	14	1
Rocca di M.	110	15
Tornimparte	137	none
Massa d'Albe	143	5
Avezzano	294	9
Capistrello	32	4
S. Benedetto	24	none
Cappadocia	7	4
Carsoli	284	20
Magliano	123	17
Oricola	16	none
Pereto	102	1
Rocca di B.	179	4
Sante Marie	100	8
Scurcola M	87	12
Tagliacozzo	405	87
L'Aquila	526	none
Totals	2841	210

respectively. The relative risk of dourine infection was higher ($R_e = 1.45$) in the AS, but this difference was not statistically significant ($P = 0.05$). The risk attributable to the unauthorized status, on the contrary, was higher than the one associated with the authorized status.

A total of 2,027 mares were examined. 703 of them were bred to authorized stallions (BAS) and 1,324 to unauthorized stallions (BUS). Fifty-seven of the BAS and 114 of the BUS were positive (Table 1), with an overall prevalence rate of 8.4%. The prevalence rates were 8.1 among BAS and

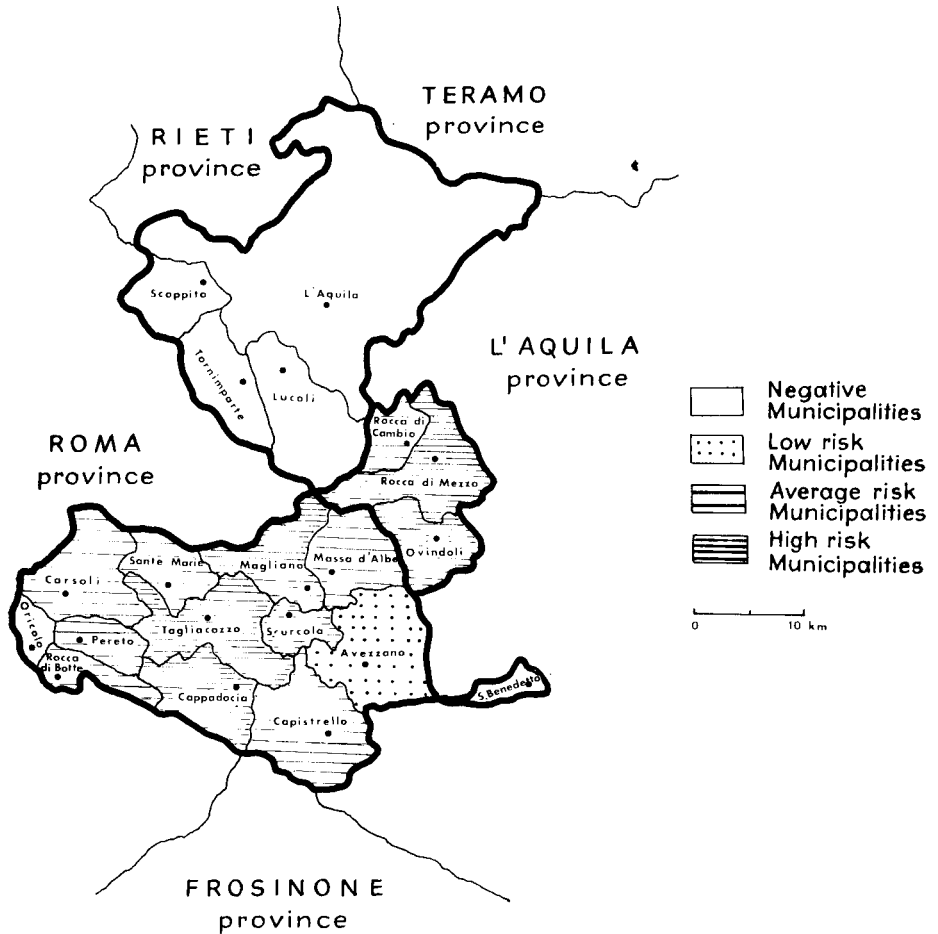


Fig. 3. Map showing municipality by class of prevalence of positive reactions

8.6 % among BUS, respectively. The relative risk of dourine infection was slightly higher ($R_e = 0.94$) in the BAS, but this difference was not statistically significant ($P = 0.05$). The risk attributable to breeding by an unauthorized stallion was, on the contrary, higher ($R. A. = 8.9$) than that attributable to breeding by an authorized stallion.

The 29 AS were bred to a total of 703 mares, while the 126 US were bred to a total of 1,324 mares. On average, therefore, each AS was bred to 24 females while each US was bred to about 11 females.

In the municipalities where positive animals were found, a statistically significant spatial clustering of cases was often observed in the mare population. To clarify the reason for this the relative risk of dourine infection was calculated for mares resident in municipalities where a positive male was also found, in comparison to mares resident in municipalities where no positive male was found. A statistically significantly higher relative risk was associated with residence in districts where a positive male, either authorized or unauthorized, was found ($R_e = 1.59$ and 2.31 for authorized and unauthorized males, respectively).

Subsequently, mares were classified according to the criterion of their owner; they were divided into those belonging to owners of positive males or

not. The relative risk was then calculated. No statistically significantly higher risk was associated with the fact of belonging to the owner of a positive male, either authorized or unauthorized.

Discussion

The infected male appears to have been the main vector for the spread of the epidemic, as demonstrated by the relative risk analysis. It is suggested that the infection spreads slowly through the mountain pastures surrounding villages where horses live in small groups during the mating season. The infection then spreads to the stallions of the authorized studs and from them to the remaining part of the population, at a more rapid rate.

By the end of the 1975 breeding season, the prevalence rate in the stallion population was 18.1 %, with rates as high as 48 % in some municipalities. There are two hypotheses to explain the high prevalence rates: (1) the infection entered the population at least one breeding season prior to the one when the survey was carried out (1975) via one or several infected horses; (2) in the period between the end of the 1974 breeding season and the beginning of the 1975 one, a very large number of infected animals were introduced into Zone A and probably into Zone C.

The latter hypothesis is unlikely. Only animals for slaughter are imported from any countries where dourine could be present. It is possible that some of these were infected and, contrary to veterinary regulations, they were introduced into the resident horse population, either for breeding or for a period of conditioning before slaughter. It is unlikely, however, that this occurred frequently.

As it is reported in the Results there is no statistically significant difference between the prevalence rates in females in an authorized stud and those in an unauthorized one; furthermore, an authorized stallion served, on average, twice as many mares as an unauthorized one. Given the same rate of transmission of the infection, it is concluded that each authorized stallion, on average, served each female half as many times as an unauthorized one. This conclusion is likely to be correct because unauthorized stallions are on pasture with the females and have unrestricted access to them.

One can therefore postulate that the spread of the infection began among horses kept on the hill pastures, where they were kept in relatively small groups, each one being with its own stallion. Subsequently, the infection passed to the foothills and spread by the males of the authorized studs, where it was recognized for the first time.

This hypothesis seems to be confirmed by 1. the larger number of positive animals found within the population kept on range pasture; and 2. in the case of horses kept on the range, the clustering of positive cases within groups which graze the same pastures. Some of the females kept on pasture are brought for service to an authorized stud, but both before and after service they graze in small groups together with a stallion which is usually unauthorized. This could be one of the ways whereby the infection extended from its open range cycle to the population kept in the stables and mostly served by authorized stallions. This hypothesis seems also to be strengthened by the example of a positive female serviced by a negative authorized stallion but kept on the range together with a positive unauthorized stallion.

The relevance of free range grazing and subsequent uncontrolled breeding in the diffusion of the epidemic seems confirmed by 1. the much lower prevalence of infection in the ass population. Asses are never kept on free range and when she-asses are mated to horse stallions they are usually brought

to authorized studs; 2. the prevalence rate in the horse population of the Avezzano Municipality was lower than expected. In this municipality, apart from isolated cases, open grazing is not practiced; 3. the epidemic although present with high prevalence rate in Zone A (Fig. 3) did not spread to Zone B. The Zone C, the only connection between them has probably functioned as buffer zone because animals grazing in the pasture of this zone never come into direct contact with those of the other two zones. In Zone A, apart from the Avezzano Municipality, there is almost no effective separation between the hill pasture of the various municipalities. Even where separation does exist, the authorized stud may have been the relay site for the spread of infection; 4. compared to the total number of mares serviced, the percentage of those mated with authorized stallions was 29.7 % in the High Risk Municipalities. This may indicate that mating is less controlled in the zone where the epidemic reached its highest diffusion. In the same zones there is also a higher density of horses.

The positive results observed in geldings and sexually immature animals is not a new phenomenon (ROBINSON, 1948) but it deserves consideration. Five of the six geldings which had positive reactions were owned by farmers who had other animals of both sexes which were, in turn, positive. One of them was also found at slaughter to be incompletely castrated. Of the two sexually immature positive females, one lived with a group of horses with a high prevalence of the infection. It may be concluded that the positive results in these two categories were due either to unsupervised mating or to non-sexual transmission.

In conclusion, the dourine epidemic in the territory examined was probably initiated by one or a few imported slaughter animals which were unlawfully kept both for breeding purposes or for a period of conditioning before slaughter. The infection spread in the free range horse population, consisting of small groups, which rarely meet, with a consequent low prevalence rate; the latter, associated with a low animal health standard, caused the disease to remain unnoticed for at least one mating season. The fact that the disease went unnoticed in the population for at least one year before its discovery can explain the rather high prevalence rate encountered in the population as a whole.

The present study seems to confirm that although non-sexual transmission cannot be excluded the coital route seems to be the most relevant one. The existing Italian regulation states that no stallion be kept unless authorized for stud and periodically subjected to veterinary control, would thus, if correctly enforced, be sufficient to eradicate the disease.

Summary

An epidemiological survey for dourine was carried out in 1975/6 in a zone of about 1,500 km.² in the Abruzzi Region. The total equine population of the area, on the basis of official census data, was estimated to be about 3,000 head. Three blood samples collected from each of the 2,841 horses and 1,958 asses were examined for *Trypanosoma equiperdum* antibody by complement fixation (CF). The average prevalence rate in the whole population was 7.4 %. Compared to the population average rate, a statistically higher rate was found in 6 municipalities, a lower rate in 1 municipality, and an average rate in 7 municipalities; 6 municipalities were found free of infection.

Trypanosoma equiperdum antibody was found in 18.1 % of the stallions, 6.8 % of the mares, 6.6 % of geldings, 4.5 % of immature males, 5.4 % of immature females, and 1.3 % of she-asses.

The reactor rate in mares submitted to controlled stud stations was 8.1 %, while in mares of uncontrolled studs it was 8.6 %. In stallions from the authorized stud stations the reactor rate was 24.1 %, in those used for unauthorized studs 16.7 %.

The prevalence rate was directly proportional to the population density of each of the 3 sub-zones in which the entire territory was divided, for geographical reasons.

On the basis of the statistical analysis of the results, hypotheses are formulated on the mode of spread of the disease in the population. If the existing Regulations in Italy governing the authorization and periodical veterinary control of all stallions could be enforced the disease could probably be eradicated.

Acknowledgements

We express our thanks to Prof. C. W. SCHWABE and A. MANTOVANI for their fruitful criticism of the manuscript.

Zusammenfassung

Epidemiologie der Dourine innerhalb der Pferdepopulation der Abruzzen

Die Dourine-Epidemiologie wurde innerhalb einer 3000 Pferde umfassenden Region der Abruzzen (Fläche 1500 km²) untersucht. Von 2841 Pferden und 1958 Eseln wurden je drei Serumproben in der Komplementbindung auf Antikörper gegen *Trypanosoma equiperdum* untersucht. Das Mittel positiver Tiere der Gesamtpopulation lag bei 7,4 %. In 6 Verwaltungsbezirken lag der Durchschnitt höher, in einem tiefer, 6 Bezirke erwiesen sich als negativ.

Antikörper konnten bei 18,1 % der untersuchten Hengste, 6,8 % der Stuten, 6,6 % der Wallache, 4,5 % der Junghengste, 5,4 % der Jungstuten und 1,3 % der Eselinnen nachgewiesen werden. Stuten in kontrollierten Gestüten reagierten zu 8,1 %, Hengste zu 24,1 %. In unkontrollierten Betrieben betrugen die entsprechenden Werte 8,6 % und 16,7 %. Eine direkte Proportion bestand hinsichtlich Populationsdichte und Reagenten.

Diese Ergebnisse sind die Grundlage einer Diskussion über die Epidemiologie der Dourine in der untersuchten Population. Kontrolle der Hengste könnte die Eradication der Krankheit ermöglichen.

Résumé

Epidémiologie de la dourine dans une population équine des Abruzzes

L'épidémiologie de la dourine a été examinée sur une population de 3000 chevaux dans une région des Abruzzes (surface 1500 km²). On a recherché par la méthode de fixation du complément des anticorps contre *Trypanosoma equiperdum* dans 3 échantillons de sérum de 2841 chevaux et 1958 ânes. La moyenne des animaux positifs de la population totale se situe vers 7,4 %. La moyenne fut plus élevée dans 6 circonscriptions, plus basse dans une et 6 régions se sont révélées négatives.

On a pu mettre en évidence des anticorps chez 18,1 % des étalons examinés, 6,8 % des juments, 6,6 % des hongres, 4,5 % des jeunes étalons, 5,4 % des jeunes juments et 1,3 % des ânesses. 8,1 % des juments et 24,1 % des étalons ont réagi dans des haras contrôlés. Ces valeurs furent de 8,6 % et 16,7 % dans des exploitations non contrôlées. Une proportion directe existe entre la densité de population et les animaux positifs.

Ces résultats sont la base d'une discussion sur l'épidémiologie de la dourine dans la population examinée. Le contrôle des étalons devait rendre possible une éradication de la maladie.

Resumen

Epidemiología de la durina en la población equina de los Abruzos

Se estudió la epidemiología de la durina dentro de la región italiana de los Abruzos (superficie 1.500 km.²), la cual alberga unos 3.000 caballos.

De 2.841 caballos y 1.958 burros se analizaron cada vez tres muestras séricas con la fijación del complemento en cuanto a la presencia de anticuerpos frente a *Trypanosoma equiperdum*. La media de animales positivos entre la población total era del orden del 7,4 %. En 6 distritos administrativos se hallaba una media más elevada, en uno más baja, mientras que 6 se mostraron como negativos.

Se pudieron identificar anticuerpos en el 18,1 % de los caballos examinados, el 6,8 % de las yeguas, el 6,6 % de los espadones, el 4,5 % de los machos jóvenes, el 5,4 % de las yeguas jóvenes y el 1,3 % de las burras. Las yeguas reaccionaban en las remontas controladas en un 8,1 %, mientras que los machos en un 24,1 %. En las explotaciones no controladas ascendían los valores correspondientes a 8,6 % y 16,7 %. Existía una proporción directa con respecto a la densidad de población y los reaccionantes.

Estos resultados son el fundamento de una discusión sobre la epidemiología de la durina en la población examinada. El control de los caballos enteros podría hacer posible la erradicación de la enfermedad.

References

1. ANON., 1975: Animal Health Yearbook FAO-WHO-OIE.
2. BAREI, S., and C. BINAGHI, 1947: Osservazioni sul Morbo Coitale Maligno. Atti Soc. It. Sci. Vet., 1, 167.
3. CAPORALE, V. P., et al., 1977: Prove comparative tra deviazione del complemento in provetta, deviazione del complemento miniaturizzata ed immuno-elettro-osmoforesi nella diagnosi del Morbo Coitale Maligno. Atti Soc. It. Sci. Vet., 31, 787.
4. DOMANSKY, F., 1949: Prispěvek k hřebci nakaze. Casopis Československ. Vet., 4, 177.
5. GRATZL, E., 1946: cited by A. KALUSCH.
6. KALIKIN, B., 1950: Utjecaj u krvi i nakad prikaza. Vet. Glasnik, 4, 39.
7. KALUSCH, A., 1949: Der Stand der Beschälseuche in Österreich. Wien. tierärztl. Monatsschrift, 36, 298.
8. KHALILI, K., 1973: An investigation of dourine and isolation of *Trypanosoma equiperdum* in Iran. Arch. de l'Institut Razi, No. 25, 69.
9. PARKIN, B. S., 1948: The demonstration and transmission of the South African strain of *Trypanosoma equiperdum* of horses. Onderstepoort J. Vet. Sci., 23, 41.
10. ROBINSON, E. M., 1948: Dourine infection in young equines. Onderstepoort J. Vet. Res., 23, 39.
11. SCHWABE, G. W., et al., 1977: Epidemiology in Veterinary Practice. Lea & Febiger, Philadelphia.
12. TOMASONI, O., 1948: Sul Morbo Coitale Maligno osservato nel Basso Veronese e curato con il «Farma 939». La Nuova Veterinaria, 24, (2), 59.

Authors' address: V. P. CAPORALE, Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise «G. Caporale», 64100 Teramo/Italy.