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DYNAMICS OF TWO RETROVIRUSES WITHIN A POPULATION OF CATS

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On étudie l'impact de deux rétrovirus, le virus de l'immunodéficience féline (VIF) et le virus de la leucose féline (VLF), dans une population d'hôte, le chat domestique. Pour cela, on construit un modèle continu déterministe. On fait une analyse mathématique du système d'équations différentielles ordinaires, on montre l'existence de différents états d'équilibre dont on étudie la stabilité locale. Les conditions obtenues sur les paramètres montrent que le VIF est toujours présent alors que le VLF n'apparaît pas dans toutes les populations. Ces résultats sont retrouvés à l'aide des simulations numériques et sont concordants avec la réalité. De plus, on note que l'impact des deux virus est supérieur à la somme des impacts des virus pris séparément.

We present a deterministic model of the dynamics of two microparasites simultaneously infecting a single host population. Both microparasites are feline retroviruses, namely Feline Immunodificiency Virus (FIV) anf Feline Leukemia Virus (FeLV). The host is the domestic cat (*Felis Catus*). The model has been tested with data generated by a long term study of several natural cat populations. Description of the model : Let N be the total number of cats at time t, and K the carrying capacity of the population at equilibrium. Natality rate b is constant, whereas the mortality rate, m, is linearly related to N, and has the form (m+rN/K), with the population intrinsic rate of increase r=b-m. The FIV transmission coefficient is s and all infected cats die from FIV infection at a rate a. FIV infected individuals do participate in reproduction, and give birth to susceptible kittens. We consider only one pathological stage, the asymptomatic period, assuming AIDS developing cats will die within a time too short to be considered in the model. FeLV is transmitted to cats at a rate g, a proportion (1-p) of which becoming naturally immunized after a short time (1 to 4 months), which is not taken into account, and are not infectious. A proportion p of cats will become infectious and die at a rate m. We consider that, as FeLV infectious pregnant females abort or give birth to infected kitten that die within a very short time, FeLV infectious cats do not participate in reproduction. Cats can be infected by both virus simultaneously, and thus die at a rate d=a+m. For biological reasons, and as previously discussed (Courchamp *et al.*, 1995; Fromont *et al.*, *in press* ; Courchamp *et al.*, *1997*), the transmission rates will be characteristic of proportionate mixing models for both FIV and FeLV. Cats not infected by either one of the two considered viruses are noted X and will be termed susceptible throughout this work. FIV infected cats are denoted Y, FeLV infectious cats are V and FeLV naturally-immunized cats W. Coinfected cats are Z if they are FeLV infectious and U if they are FeLV naturally-immunized. The compartmental representation is shown Figure 1.

A set of first order equations describes the dynamics of the FIV and FeLV infected cat population as given by the above hypothesis.

Figure 2 shows all the different behaviours of the model, but stability analysis and simulations show that, with the real parameters, once introduced in a population, FIV spreads and is maintained, while FeLV can either disappear or persistes. Moreover, introduction of both viruses into the population induces an equilibrium state for individuals of each different pathological class. The viruses never induce the extinction of the population. Furthermore, whatever the outcome for the host population (persistence of FIV only, or both viruses), the global population size at the equilibrium state is only slightly lower than it would have been in the absence of the infections (i.e. at the carrying capacity), indicating a low impact of the viruses on the population. Finally, the impact of the diseases examined simultaneously is higher than the sum of the impact of the two diseases examined separately. This seems to be due to a higher mortality rate when both viruses infect a single individual.

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Figure 1
Flow chart of the population infected by both FIV and FeLV

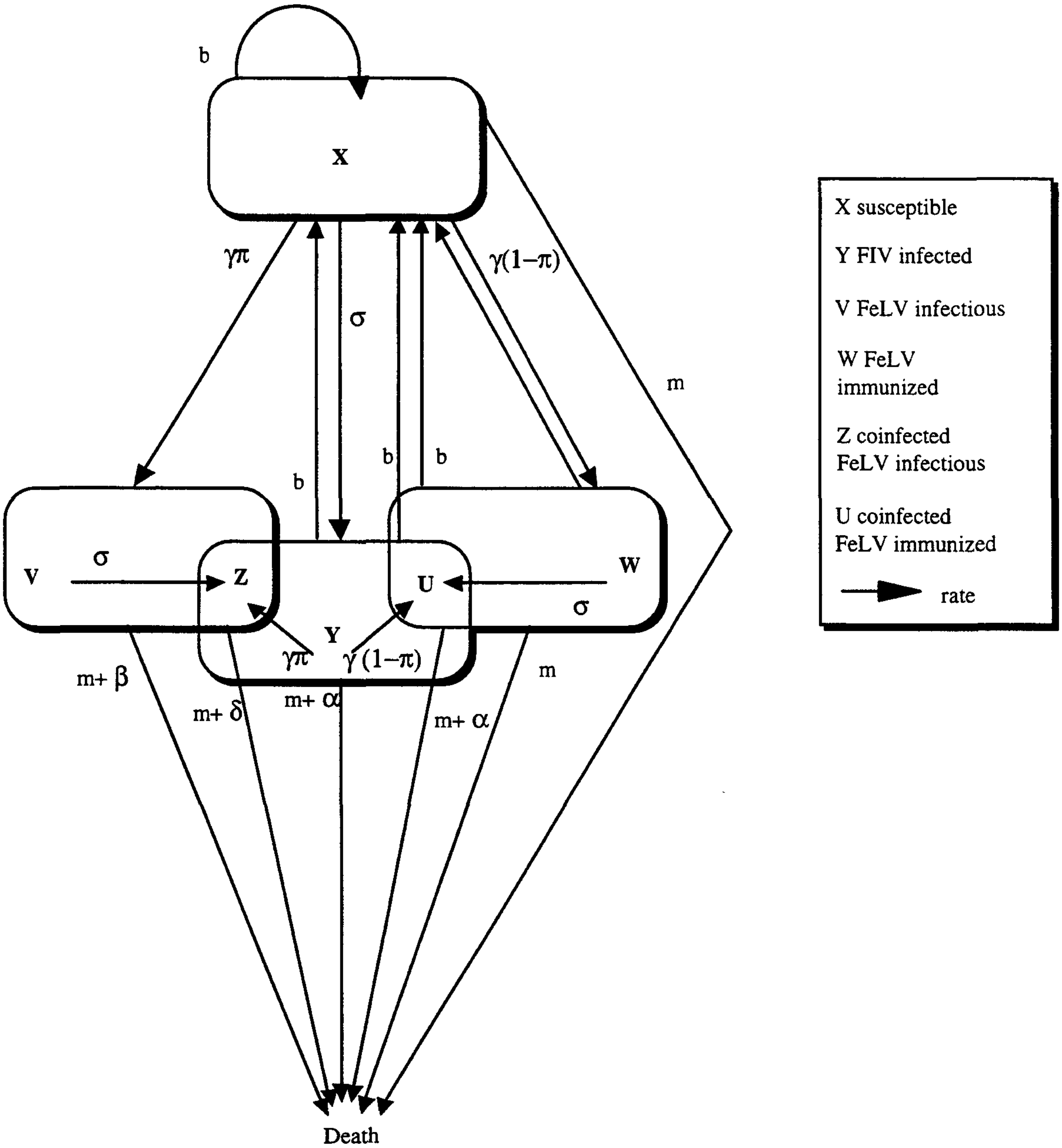
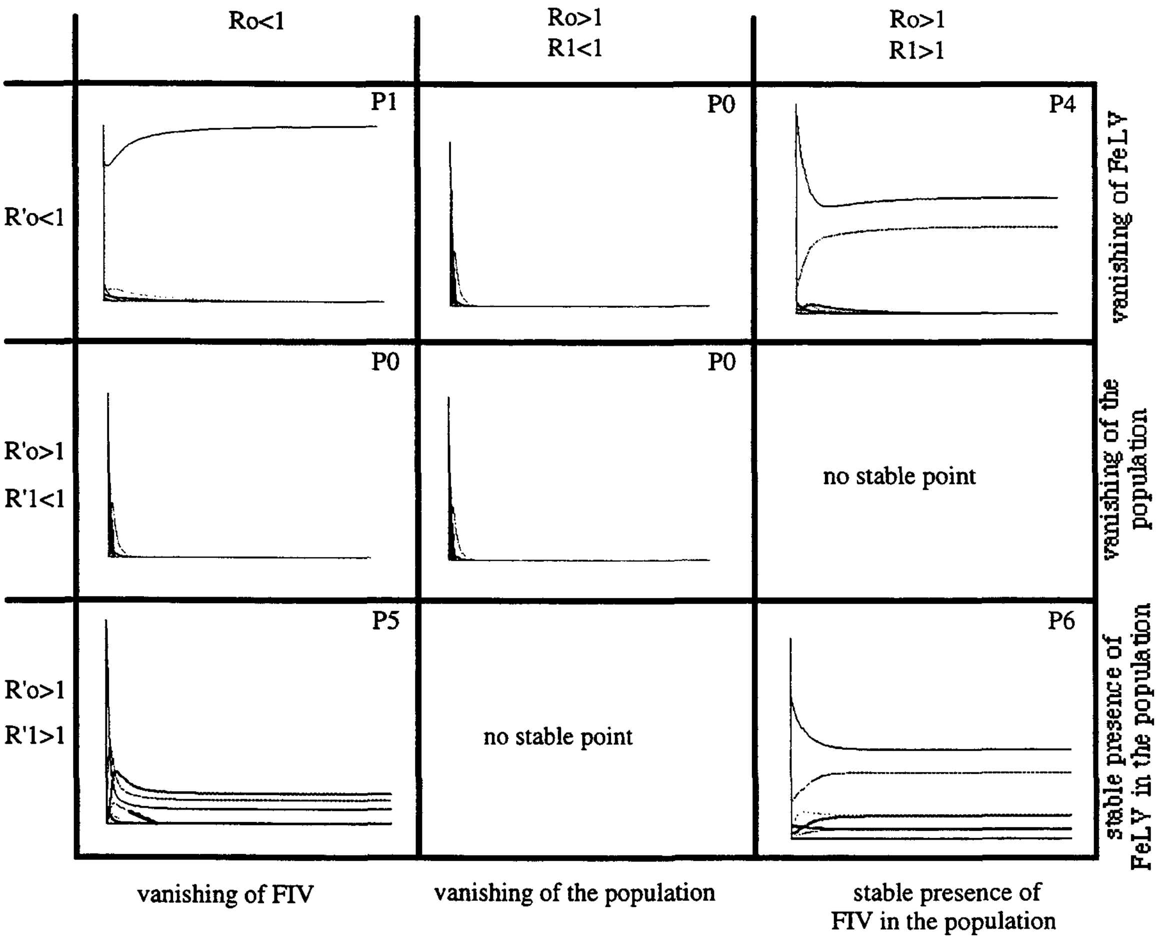


Figure 2
Summary of possible outcomes for the model behaviour, in function of R_0, and R_1 in the columns and of R'_0, and R'_1 in the rows.
Simulations illustrate each of the cases



BIBLIOGRAPHY

Courchamp F., Pontier P., Langlais M., Artois M., 1995. Population dynamics of Feline Immunodeficiency Virus within cat populations. J. Theor. Biol., 175, 553-560.

Fromont E., Lanflais M. Courchamp F., Artois M., Pontier P. Modelling the feline leukemia virus (FeLV) in natural populations of cats (*Felis catus*). Theor. Pop. Biol. In press.

Courchamp F., Suppo Ch., Fromont E., Bouloux C., 1997. Population Dynamics of two Feline retroviruses (FIV and FeLV) xithin one Population of Cats. Proceedings of Royal Society of London, to appear.