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Characterization of a Foamy Virus Isolated from *Cercopithecus aethiops* Lymphoblastoid Cells

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Abstract. A virus derived from cells of a lymphoblastoid line originating from the lymph node of a healthy African green monkey was characterized as a typical member of the foamy virus subgroup of retroviridae by its morphological, physicochemical, biological and biochemical properties (reverse transcriptase actvity). Besides the usual host range of foamy viruses, the isolated strain revealed a remarkable T-lymphotropism, distinguishing it from the prototypes of foamy viruses previously isolated from African green monkeys. Two foamy virus infections are demonstrated in human contacts of the African green monkey colony, with the animal harbouring the isolate.

Introduction

Foamy viruses have been known for nearly three decades as agents causing persistent infections in wild and laboratory animals, including primates [6]. The presence of an RNA-dependent DNA polymerase (RDDP) in the virion as well as certain physicochemical and morphological characteristics are properties that these viruses have in common with retroviruses. Typical cytopathogenicity in a variety of cell cultures and the appearance of viral antigens in the cell nucleus during virus multiplication, however, identify foamy viruses as an individual subgroup within the family of retroviridae [6]. Several reports have indicated that infections with viruses similar to or identical with simian foamy viruses occur in man [1, 8–10, 15]. Nevertheless, the biological significance of foamy virus infections, especially their pathogenetic potential, has so far remained undefined. Isolation of foamy viruses from monkeys, apes and on rare occasions from man has mostly been achieved by culturing cells of normal organ tissue or tumors. Although in the latter case the association with tumorigenesis has been discussed, the foamy viruses are usually regarded as incidental passengers rather than aetiologcal agents

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[6, 11, 13]. The isolate described in this paper was especially interesting because of its remarkable tropism for human T-lymphoid cells. Moreover, serological screening in simian and human contacts of the monkey originally harbouring the virus revealed further examples of human infection by foamy viruses.

Materials and Methods

Cells

Molt-4 (T-cell leukaemia), BJAB (EBV-negative Burkitt's lymphoma) and Raji (EBV-positive Burkitt's lymphoma) cells were kindly provided by Dr. G. Klein, Stockholm, Sweden.

MT-1 cells [14] were provided by Dr. N. Yamamoto, Kyoto, Japan; VERO (African green monkey) cells were obtained from Dr. G. Enders-Ruckle, Stuttgart, FRG; L-929 (mouse) cells from Dr. G.A. Luckenbach, Freiburg, FRG and BHK 21 (hamster) cells from the American Type Culture Collection.

African green monkey fibroblasts and kidney cells as well as human diploid foreskin fibroblasts (strain alpha-1) were initiated in this laboratory. All cells were routinely passaged twice weekly and kept in RPMI 1640 medium (for the cells of lymphatic origin) or in Eagle's minimal essential medium, both supplemented with fetal calf serum (10% and 5%, respectively), penicillin (100 μ/ml) and streptomycin (100 μg/ml).

Viruses

The isolate designated LK-3 was derived, together with two additional viruses [16], from cultured lymph node cells of a healthy African green monkey (*Cercopithecus aethiops*). While the other viruses present in the original cell line (an EBV-like herpesvirus and a papovavirus) displayed B-lymphotropic properties [16], LK-3 could be transferred to the human T-cell leukaemia line Molt-4. Stocks of infected Molt-4 cells kept in liquid N_2 were the basis for all further investigations. For the preparation of cell-free virus stocks, infected alpha-1 fibroblasts were scraped off the bottom of the culture vessel, washed and resuspended in phosphate-buffered saline (PBS) pH 7.4, and sonicated on ice. The cell debris was removed by centrifugation at 3000 *g* for 15 min at 4°C and the supernatant was frozen in aliquots at -70°C. Prototype strains of simian foamy virus types 1, 2, 3 and 7 were obtained from the American Type Culture Collection, and human foamy virus [1] was kindly provided by Dr. M.A. Epstein, Bristol, England.. These viruses were adapted to alpha-1 fibroblasts. Stocks of infected cells were kept in liquid N_2, and cell-free virus stocks were prepared as described for LK-3.

Immunofluorescence Assay

Indirect immunofluorescence was performed with lymphoid cells as described by Henle and Henle [5], using methanol for fixation at -20°C. Monolayer cells grown on glass slides in petri dishes were fixed and further processed by the same method. Sera were usually applied at a 10^{-1} dilution in PBS. Fluorescein-conjugated anti-human IgG was purchased from Behringwerke AG, Marburg, FRG.

Assay for Viral Infectivity

For titration in monolayer cell cultures, 150-μl aliquots of serial tenfold dilutions of the samples were mixed with equal volumes of cell suspensions freshly prepared by trypsinization, and immediately seeded onto glass slides. After 30 min incubation (Co_2 incubator, 37°C) to settle the cells, sufficient medium for further cultivation in petri dishes was added. Three days after seeding, the slides were fixed and examined by immunofluorescene with positive and negative control sera. At the appropriate dilutions the foci of fluorescent, infected cells were counted to estimate the infectious units in the sample.

Titration in Molt-4 cell cultures was done essentially in the same way, using cells concentrated from exponentially growing cultures by low-speed centrifugation. After 30 min virus adsorption onto the concentrated cells, 5-ml suspension cultures were initiated and examined for fluorescent cells 3 days after infection.

Neutralization Assay

All neutralization tests were done using alpha-1 fibroblasts and alpha-1 adapted cell-free test virus preparations diluted to contain 1000 infectious units/ml. Equal 75-μl volumes of test virus and 10^{-1} diluted serum samples were mixed, incubated at 4°C for 4 - 15 h, and assayed for remaining infectivity as already described. Control titrations of test virus were done in all tests.

Electron Microscopy

Infected cultures were scraped, the cells washed in PBS and resuspended in 2.5% glutaraldehyde in PBS (pH 7.4) at O°C for 1 - 6 days, then postfixed with 1% osmium tetroxide in PBS (pH 7.2) at 2O°C for 1 h. The cells were then dehydrated in alcohol, embedded in Epon, and thin-sectioned by standard techniques. Sections were counterstained with uranyl acetate-lead citrate. For negative staining 2% sodium phosphotungstate (pH 7.2) was applied to material adsorbed onto carbon-coated grids.

Reverse Transcriptase Assay

To demonstrate RNA-dependent DNA polymerase (RDDP) activity, infected BHK-21 cells and uninfected control cells of the same batch of cultures were scraped, washed in PBS, and resuspended in distilled water at 0°C for swelling. For hours later the cells were lysed by 12 strokes of a Dounce homogenizer in ice, and after adding one volume of STE buffer (0.1 M NaCl, 0.01 M Tris-HCL, pH 8.0, 0.001 M EDTA) the nuclei were removed by centrifugation at 1200 *g* and 4°C for 5 min. The cell debris was removed by another centrifugation at 10 000 *g* for 15 min, and finallly RDDP-containing material was pelleted from the supernatant by centrifugation at 81 000 *g* in an SW-27 (Beckman) rotor at 4°C for 90 min. The pellets were resuspended in double-concentrated reaction buffer containing Tris, KCL, dithiothreitol (DTT) and Nonidet P-40 (NP-40). Aliquots of the preparation were frozen at -20°C.

For partial purification of LK-3 virions, infected cells were scraped, washed and resuspended in PBS, and disrupted by sonication in ice. After clarification by centrifugation at 3000 *g* and 4°C for 20 min, the supernatant was layered over a discontinous sucrose gradient (SW-27, 5 ml 50% sucrose, 10 ml 20% sucrose in STE buffer) and centrifuged at 81 000 *g* and 4°C for 3 h. The material found on top of the 50% cushion

was collected, adjusted to 22% sucrose and layered over a continuous 25%—50% sucrose gradient for centrifugation in an SW-27 rotor at 81 000 *g* and 4°C for 15 h. Fractions of 3 ml were collected and tested for infectivity and RDDP activity. The concentration of sucrose in the fractions was determined by refractometry. The virus-containing fractions (density 1.15—1.18 g/cm^3) were diluted tenfold in STE and centrifuged for 3 h in an SW-27 rotor at 81 000 *g* and 4°C. The pellets were resuspended as already described.

The RDDP test was performed according to the procedure described earlier [3], in standard reaction volumes of 100 μl containing 0.2% NP 40, 0.05 *M* Tris-HCl, pH 7.8, 0.05 *M* KCl, 0.001 *M* DTE and either 0.001 *M* manganese chloride or 0.01 *M* magnesium sulphate. For transcription of a synthetic homopolymeric RNA, 2 μg $(rC)_n - (dG)_{12\text{-}18}$ template-primer (Boehringer, Mannheim, FRG), and 5 μCi ^{3}H-dGTP were present in each 100-μl test volume. For transcription of endogenous heteropolymeric templates, the reaction mixture contained 20 μCi/100 μl ^{3}H-dGTP with a specific activity of 12.2 Ci/mmol, or (in preparative reactions) 100 μCi/100 μl ^{32}P-dCTP with a specific activity of 200—400 Ci/mmol, and the addtitional unlabelled deoxynucleoside triphosphates in an end concentration of 0.6 m*M*.

Results

Host Range in Cell Cultures

In Molt-4 cells infection with the LK-3 isolate caused a specific cytopathic effect (CPE) consisting of ballooned cells that were intensively stained by immunofluorescence with sera containing antibody against LK-3, but not by control sera (Fig. 1a and b). Once the CPE had occurred, LK-3 killed all cells of the cultures within a few days. Transfer of LK-3 by culture fluids passed through 450-nm filter membranes was rather inefficient, resulting in a long lag period of cytopathic changes (Table 1), whereas serial passages of 0.5%—1% of infected cells into growing Molt-4 suspensions yielded 100% infected cultures within 48 h.

Sonically disrupted, Lk-3-infected Molt-4 cells were used to infect human diploid fibroblasts (alpha-1), African green monkey (AGM) fibroblasts and secondary AGM kidney cells, VERO cells, BHK-21 hamster cells and L-929 mouse cells. After two to three subcultivations, cytopathic changes characteristic of foamy viruses appeared in all of these cells (Fig. 1c). The multinucleated, vacuolated CPE cells initially showed bright nuclear fluorescence (Fig. 1d) with sera containing antibodies against LK-3. In later stages of syncytium formation, viral antigens were preferentially present in the cytoplasm (Fig. 1e). In the monolayer cultures, as in Molt-4, the propagation of LK-3 infection was most easily achieved by co-cultivation of infected and uninfected growing cells. Various cell-free preparations from infected cell cultures yielded only low titres of infectivity (Table 1), which proved to be ether-sensitive.

Clarified supernatants of sonicated LK-3-infected alpha-1 fibroblasts were used to infect cultures of Molt-4, MT-1, BJAB and Raji cells for comparative studies of the lymphotropic properties of the virus. Three days after infection, in all types of cultures individual infected cells could be identified by immunofluorescence, and infectivity was recovered by co-cultivation with alpha-1 fibroblasts. However, only in Molt-4 did subcultivation and co-cultivation with uninfected cells result in the formation of CPE

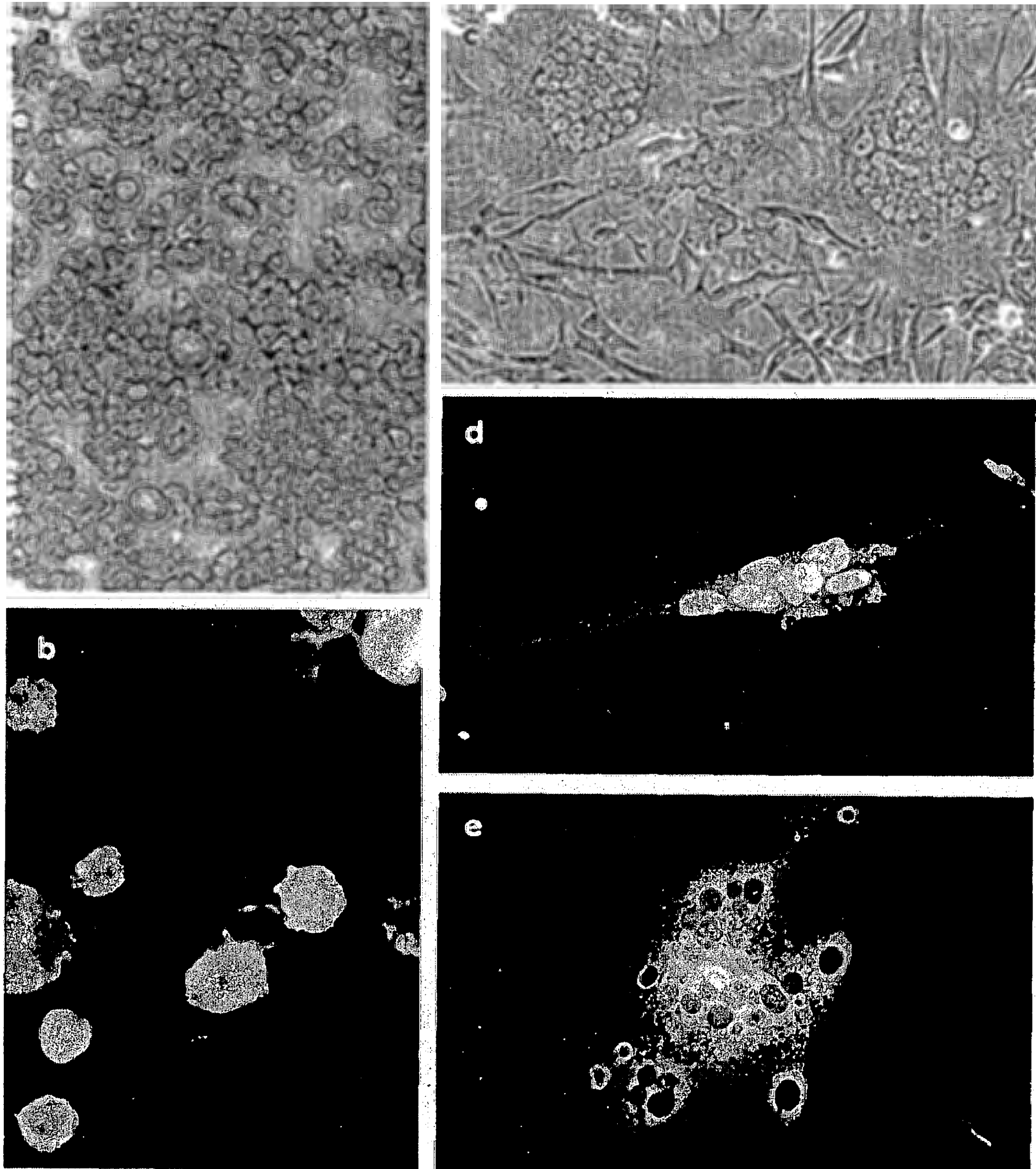

Fig. 1 a-e. Morphological changes in LK-3-infected cell cultures. a Cytopathic effect (CPE) in Molt-4 cells; b immunofluorescence of infected Molt-4 cells with serum of an LK-3-infected African green monkey; c CPE in BHK-21 cells; d immunofluorescence in infected alpha-1 fibroblasts 24 h post infection, and e 72 h post infection

and spreading infection. In the other cultures, no CPE appeared and the number of fluorescent cells decreased upon subcultivation and co-cultivation. In some experiments, the infected cultures finally degenerated without evidence of productive LK-3 infection.

Electron Microscopy

In thin sections of infected BHK-21, VERO, Molt-4 and alpha-1 cells, retrovirus-like particles were seen in cytoplasmic vacuoles, or budding from the cytoplasmic membrane (Fig. 2a and b). In material pelleted from supernatants of infected cultures as well as

Table 1. Infectivity of different preparations from various LK-3-infected cell cultures

Sample of infected cultures	Infectious units[a]/ml
Molt-4 culture fluid – millipore (450 nm) filtrate	$< 10^1$ [b]
Molt-4 (10^6 cells/ml) sonicated – 3000 *g* supernatant	10^2
BHK-21 culture fluid	
– millipore filtrate	10^1
– untreated	10^3
Alpha-1 fibroblasts – culture fluid untreated	$< 10^1$ [b]
Alpha-1 (10^6 cells/ml) sonicated	
– 3000 *g* supernatant	$10^{4,5}$
– 3000 *g* supernatant ether-treated	$< 10^1$

[a]Fluorescent focus-forming units estimated in infected test cultures of the respective cell species
[b]Infectivity demonstrable only after subcultivation of test cell culture

in clarified preparations of cells disrupted after infection, viral particles were rarely demonstrated by negative staining. Figure 2c shows LK-3 particles extracted from disrupted alpha-1 fibroblasts by Freon treatment. The fact that the structure of the viral envelopes is often disrupted is probably due to the extraction procedure. Diameters of about 50 nm for the cores and 100–110 nm for the virions were estimated from examinations by electron microscopy.

Reverse Transcriptase

An RNA-dependent DNA polymerase (RDDP) activity was demonstrated in cytoplasmic extracts of LK-3-infected BHK-21 cells and in alpha-1 fibroblasts, but not in uninfected cells (Table 2). It was shown that the LK-3-derived RDDP preferred Mg^{2+} to Mn^{2+} for transcription of a synthetic RNA template ($(\text{rC})_n$) into DNA (Fig. 3). For reverse transcription of the endogenous viral RNA genome, LK-3 was partly purified from infected alpha-1 cells. Fractions with a density between 1.15 and 1.18 g/cm^3, prepared by equilibrium centrifugation in sucrose, showed infectivity for alpha-1 fibroblasts and RDDP activity using an $(\text{rC})_n - (\text{dG})_{12\text{-}18}$ template-primer complex. These fractions were also assayed without a synthetic template-primer, but with the complete set of deoxynucleoside triphosphates. The reaction product was precipitated by adding two volumes of ethanol, denatured in 0.1 M NaOH at 65°C for 1 h, and shown by chromatography on a Sephadex G-50 column to contain high molecular DNA (data not shown).

Natural and Experimental Infections in Animals and Man

The original host monkey of LK-3 had been killed for preparation of kidney cell cultures before the virus was isolated from his lymph node cells. Therefore, only its former contacts in the monkey colony could be studied. Sera from 17 of 20 African green mon-

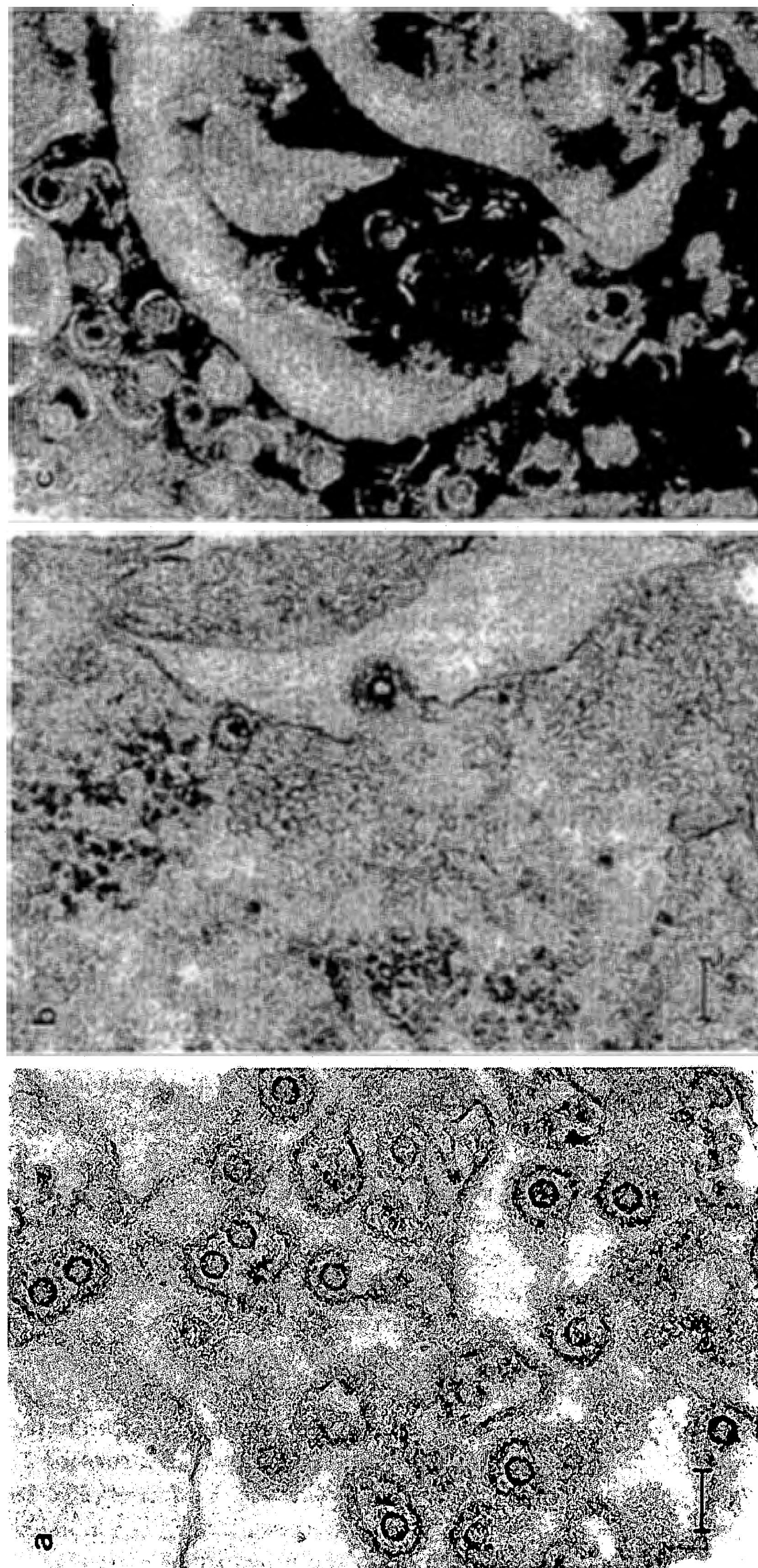

Fig. 2 a-c. a, b Thin sections of LK-3-infected BHK-21 cells showing virus particles in an intracytoplasmic vacuole (a) and budding from the cytoplasmic membrane (b). **c** Negatively stained LK-3 particles extracted from infected alpha-1 cells by Freon treatment. *Bar* marks 100 nm

Table 2. Specificity of RNA-dependent DNA polymerase extracted from LK-3-infected BHK-21 cells

Substrate	Template	Primer	Additive to standard reactions mixture	TCA-precipitated radioactivity (%)
^{3}HdGTP	$(rC)_n$	$(dG)_{12-18}$	–	100
^{3}HdGTP	$(rC)_n$	$(dG)_{12-18}$	Actinomycin D[a]	118
^{3}HdGTP	$(rC)_n$	$(dG)_{12-18}$	RNAse[b]	5
^{3}HdGTP	$(rC)_n$	$(dG)_{12-18}$	LK-3- immune serum[b]	5
^{3}HdGTP	$(rC)_n$	$(dG)_{12-18}$	Preimmune serum[b]	40
^{3}HdTTP	$(rC)_n$	$(dG)_{12-18}$	–	5
^{3}HdGTP	–	$(dT)_n$	–	5
^{3}HdGTP	–	–	–	5
^{3}HdGTP	$(rC)_n$	$(dG)_{12-18}$	Standard reaction mixture with extract from non-infected BHK-21 cells	6.5

[a] 50 μg/ml
[b] Pre-incubation at 4°C overnight

keys (kept in single or twin cages) and from 7 rhesus monkeys (*Macaca mulatta*), which were in contact with the green monkeys, gave positive reactions in immunofluorescence tests with LK-3-infected cells. Throat swabs of most of the seropositive monkeys yielded isolates causing a typical foamy virus CPE in alpha-1 fibroblast cultures. Only a few of these isolates, however, could be successfully transferred into Molt-4 cells. This finding, together with the differences in neutralization patterns of individual sera (Table 3), suggested the presence of different types of foamy viruses in the colony. All the monkeys appeared to be healthy at the time of positive virus isolation and did not develop apparent disease during a 1-year period of observation. In some of these animals continuous virus shedding during this peroid was demonstrated by repeated virus isolation.

Experimental infection with LK-3 was carried out by subcutaneous injection of infected VERO cells into a green monkey lacking evidence of any former infection by foamy viruses. The only symptom upon infection was generalized lymphadenopathy beween days 6 and 13 post infection (p.i.). On day 14 p.i., seroconversion occurred and virus was isolated from throat swabs for the first time on day 15 p.i. and on several occasions thereafter, while the monkey remained healthy. Infecting newborn and 4-week-old mice as well as adult hamsters, using infected homologous cells (L-929 and BHK-21, respectively), did not result in disease. Staff members working with the rhesus and African green monkeys underwent serological examinations, which identified 2 of 35 individuals revealing positive immunofluorescence with LK-3 infected cells. The seropositive individuals had worked for years as animal keepers in the green monkey colony, one being apparently healthy at present and without history of particular

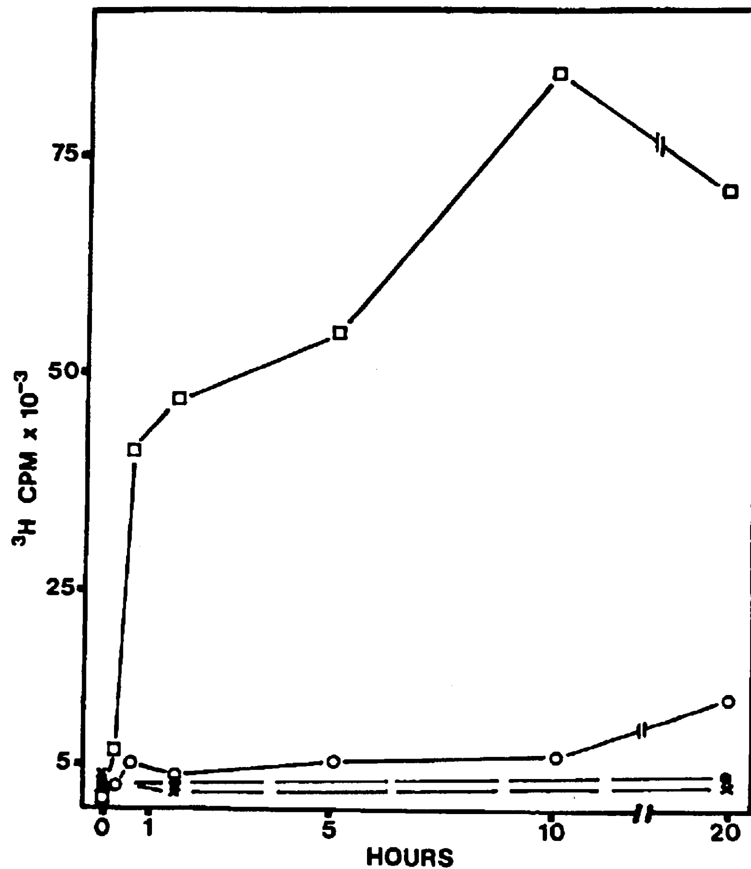

Fig. 3. RNA-dependent DNA polymerase (RDDP) activity. Acid-precipitated radioactivity in an $(rC)_n - (dG)_{12-18}$ dependent RDDP reaction in the presence of LK-3-infected BHK-21 cell extract and Mg^{2+} □, LK-3-infected BHK-21 cell extract and Mn^{2+} ○, LK-3-infected BHK-21 cell extract, without divalent cations •, BHK-21 cell extract and Mg^{2+} as well as Mn^{2+} x

Table 3. Neutralization of LK-3 and simian foamy virus prototype strains by different human and monkey sera reacting positively in immunofluorescence assays with LK-3-infected cells

Serum from	Foamy virus				
	LK-3	SFV-1	SFV-2	SFV-3	SFV-7
Animal keeper A	–	–	–	+	–
Animal keeper B	+	+	–	+	–
Chimpanzee	+	–	+	–	+
Rhesus monkey	–	+	–	–	–
African green monkey (AGM)	–	+	–	+	–
LK-3-infected AGM					
– immune	+	–	–	–	+
– preimmune	–	–	–	–	–
Human negative control	–	–	–	–	–

infectious diseases. The other died at the age of 63 following an accident, after retiring 1 year earlier.

Further screening of sera from routine examinations and from patients with tumours and immunological disorders have not revealed positive reactions so far.

Comparison with Foamy Virus Prototype Strains

Inoculation of lymphoid cell cultures (Molt-4, MT-1, BJAB and Raji) with simian foamy virus (SFV) types 1, 2, 3 and 7, as well as with human foamy virus, resulted in the type of infection described for LK-3 with MT-1, BJAB and Raji. In none of these cell lines did any of the prototype strains cause the progressive type of infection that was described for LK-3 in Molt-4. It was of interest that in one experiment the SFV-1 infection in Raji caused a pronounced CPE similar to that of LK-3 infection in Molt-4. However, the infected cultures did not die upon subcultivation, although the ballooned CPE cells persisted in the cultures, their reaction in immunofluorescence with positive sera turning from positive to negative. As infectious SFV-1 could be reisolated from the fluorescence-negative subcultures, these Raji cells may prove to be persistently infected with SFV-1.

Comparative immunofluorescence testing on infected alpha-1fibroblasts was carried out with sera from the two antibody-positive animal keepers, from rhesus and green monkeys of the colonies studied, from the monkey experimentally infected with LK-3 and from chimpanzees. Cross-reactivity was observed with cells infected by SFV types 1, 2, 3 and 7, human foamy virus and LK-3, except that sera from the green monkeys including that from the LK-3 infected animal and from one animal keeper did not stain cells infected by human foamy virus. The sera from a human control and the preinfection serum from the green monkey, which was experimentally infected, were negative in the complete setting. Together with the results of preliminary neutralization tests (Table 3) and the host range properties, the immunofluorescence pattern suggests there is a close relationship between LK-3 and SFV types 1, 2, 3 and 7, but not that they are identical.

Discussion

The LK-3 isolated from cells of a lymphoblastoid line originating from a lymph node of an African green monkey was characterized as a typical member of the foamy virus subgroup of retroviruses by its morphology and physicochemical properties, its biological properties in animals and in cell cultures, as well as by its reverse transcriptase activity. Though the isolate has not yet been compared with all known serotypes of simian foamy viruses, and the type identity is still undefined, its T-lymphotropic property seems to distinguish it from other simian foamy viruses. Isolation of foamy viruses has been reported repeatedly from peripheral blood leucocytes [2,4,12] and from lymph node tissue [7]. Growth and persistence of foamy viruses in lymphoid cells or cell lines derived from primate lymphoid cells, however, have not been studied systematically so far. The T-lymphotropic properties of LK-3 as well as the modalities of persistence in cells of B-lymphoid origin will require further evaluation. The presence of an RNA-dependent DNA polymerase in the LK-3 virions and in infected cells, suggesting that viral cDNA plays a central role in the replication cycle,

should permit the study of these phenomena on the nucleic acid level with the aid of molecular cloning techniques.

It is noteworthy that two human infections with a foamy virus were found on serological examination in the staff members working with contacts of the monkey harbouring LK-3, although neutralizing antibodies against LK-3 could only be demonstrated in one of the individuals. In the literature [6] a very low incidence of accidental human infection by simian foamy viruses has been reported, whereas the prevalence of antibodies to he human foamy virus was found to be relatively high in certain populations [8,9]. The source of the foamy virus infections and the mode of their spread in these populations, as well as their biological role in the infected individuals, however, are still unclear. Previous reports are in accordance with our observations, and leave no doubt that foamy virus infection may accur in man. The peculiar persistence of these infections should lead to further studies of their epidemiological and biological properties

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References

1. Achong BG, Mansell PWA, Epstein MA, Clifford P (1971) An unusual virus in cultures from a human nasopharyngeal carcinoma. J Natl Cancer Inst 46:299–230
2. Barahona H, Garcia FG, Melendez LV, King NW, Ingalls JK, Daniel MD (1976) Isolation and characterization of a lymphocyte associated foamy virus from a red uakari monkey (cacajao rubicundus). J Med Primatol 5:253–265
3. Bauer G, Friis RR, Mattersberger H, Hofschneider PH (1978) Controlled release of particle-associated RNA-dependent DNA polymerase by primary chick embryo cell cultures. Exp Cell Res 117:383–392
4. Feldman MD, Dunnick NR, Barry DW, Parkman PD (1975) Isolation of foamy virus from rhesus, African green and cynomolgus monkey leukocytes. J Med Primatol 4: 287–295
5. Henle W, Henle G (1966) Immunofluorescence in cells derived from Burkitt's lymphoma. J Bacteriol 91:1248–1256
6. Hooks JJ, Gibbs JRCJ (1975) The foamy viruses. Bacteriol Rev 39:169–185
7. Hooks JJ, Gibbs JRCJ, Cutchins EC, Rogers NG, Lampert P, Gajdusek DC (1972) Characterization and distribution of two new foamy viruses isolated from chimpanzees. Arch Gesamte Virusforsch 38:38–35
8. Loh PC, Matsuura F, Mizumoto C (1980) Seroepidemiology of human syncytial virus: antibody prevalence in the Pacific. Intervirology 13:87–90
9. Muller HK, Ball G, Epstein MA, Achong BG, Lenoir G, Levin A (1980) The prevalence of naturally occurring antibodies to human syncytial virus in East African populations. J Gen Virol 47:399–406
10. Nemo GJ, Brown PW, Gibbs JRCJ, Gajdusek DC (1978) Antigenic relationship of human foamy virus to the simian foamy viruses. Infect Immun 20:69–72
11. Rabin H, Neubauer RH, Woodside NJ, Cicmanec JL, Wallen WC, Lapin BA, Agrba VA, Yakoleva LA, Chuvirov GN (1976) Virological studies of baboon (Papio hamadryas) lymphoma: isolation and characterization of foamy viruses. J Med Primatol 5:13–22

12. Rhodes-Feuillette A, Saal F, Lasneret J, Dubouch P, Périès J (1979) Isolation and characterization of a new simian foamy virus serotype from lymphocytes of a Papio cynocephalus baboon. J Med Primatol 8:308–320
13. Schnitzer TJ (1981) Characterization of a simian foamy virus isolated from a spontaneous primate lymphoma. J Med Primatol 10:312–328
14. Yamamoto N, Schneider J, Hinuma Y, Hunsmann G (1982) Adult T-cell leukemia-associated antigen (ATLA): detection of a glycoprotein in cell- and virus-free supernatant. Z Naturforsch [c] 37:731–732
15. Young D, Samuels J, Clarke JK (1973) A foamy virus of possible human origin isolated in BHK-21 cells. Arch Gesamte Virusforsch 42:228–234
16. Zur Hausen H, Gissmann L, (1979) Lymphotropic papovaviruses isolated from African green monkey and human cells. Med Microbiol Immunol 167:137–153

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