Virus Name: Powassan	Abbreviation: POWV

Status
Arbovirus

Select Agent
No

SALS Level
3

SALS Basis
Results of SALS surveys and information from the Catalogue.

Other Information
DOC Permit Required

Antigenic Group
B

SECTION I - Full Virus Name and Prototype Number

Prototype Strain Number / Designation
strain L.B.

Accession Number

Original Date Submitted
1/21/1985

Family
Flaviviridae

Genus
Flavivirus

Information From
Donald M. McLean, M.D.

Address
Division of Medical Microbioloby, Univ. of British Columbia, Vancouver, B.C. V6T 1W5, Canada

Information Footnote

Section II - Original Source

Isolated By (name)
Donald M. McLean (1)

Isolated at Institute
Hosp. for Sick Children, Toronto, Canada

Host Genus
Man

Species

Host Age/Stage
5 years

Sex
Male

Isolated From

Isolation Details

Signs and Symptoms of Illness
Acute encephalitis, 6 days between onset and death; headache, fever, twitching drowsiness, spastic hemiplegia

Arthropod

Time Held Alive before Inoculation

Collection Method
CNS tissues collected at autopsy

Collection Date
9/23/1958

Place Collected (Minimum of City, State, Country)
Residence, Powassan, Ontario, Canada

Latitude
46° N

Longitude
7° W

Macrohabitat
Farm about 5 mi. west of Powassan; cultivated patches alternate with rocky terrain forested by mixed spruce and deciduous trees.

Microhabitat

Method of Storage until Inoculated
Inoculated immediately, aliquot stored at -70dC

Footnotes

Section III - Method of Isolation

Inoculation Date
9/23/1958

Animal (Details will be in Section 6)
nb mice

Route Inoculated
Intracerebral

Reisolation
Yes

Other Reasons

Homologous Antibody Formation by Source Animal

Test(s) Used

Footnotes

Section IV - Virus Properties

Physicochemical

Pieces (number of genome segments)	Infectivity	Sedimentation Coefficients(s) (S)
Percentage wt, of Virion Protein	Lipid	Carbohydrate
Virion Polypeptides: Number	Details	
Non-virion Polypeptides: Number	Details	
Virion Density	Sedimentation Coefficients(s) (S)	
Nucleocapsid Density	Sedimentation Coefficients(s) (S)	

Stability of Infectivity (effects)

pH (infective range)

Lipid Solvent (ether - % used to test)	After Treatment Titer	Control Titer
Lipid Solvent (chloroform)	After Treatment Titer	Control Titer
Lipid Solvent (deoxycholate) **1:1000**	After Treatment Titer **nil**	Control Titer **5.0 dex**

Other (formalin, radiation)

Virion Morphology

Shape
Icosahedron

Dimensions

Mean
nm

Range
40-45nm

Measurement Method **EM of thin sections and phosphotungstic preps**	Surface Projections/Envelope **Enveloped**	Nucleocapsid Dimensions, Symmetry **39 nm, cubic symmetry**

Morphogenesis

Site of Constituent Formation in Cell
Cytoplasm

Site of Virion Assembly
Cytoplasmic vacuoles

Site of Virion Accumulation
Cytoplasm

Inclusion Bodies
None

Other

Hemagglutination

Hemaggiutination
Yes

Antigen Source
SMB ext. by sucrose-acetone; acetone-ether; borate + prot.

Erythrocytes (species used)
Goose

pH Range
6.4-6.8

pH Optimum
6.6

Temperature Range
4-37dC

Temperature Optimum
22dC

Remarks

Serologic Methods Recommended
HI, CF, NT

Footnotes

Section V - Antigenic Relationship and Lack of Relationship to Other Viruses

McLean and Donohue [1]

Immune sera (guinea pigs) 2 to 4 injs.	Antigen of Powassan virus			Antigens	Immune serum of Powassan virus		
	HI	CF	NT		HI	CF	NT
Powassan	640	160	100+	Powassan	640	160	100+
St. Louis	320/ND *	0/160 *	0/400 *	St. Louis		0/160	0/400
Murray Valley	40/ND	0/160	0/1000	Murray Valley		0/160	0/1000
Eastern equine	0/160	0/320	0/100+	Eastern equine		0/320	0/100
Western equine	0/ND	0/20	0/100	Western equine		0/20	0/100

* Heterologous/homologous

NT: serum dilution plaque-reduction neutralization titers

Casals [2]

	Antigen of Powassan virus				Immune serum of Powassan virus		

	Antigen of Powassan virus				Immune serum of Powassan virus		
Immune sera (mice) several injs	**HI**	**CF**	**NT**	**Antigens**	**HI**	**CF**	**NT**
Powassan	320	128	1000	Powassan	320	128	1000
RSSE	160/5120 *	128/512 *	110/300 *	RSSE	160/5120	32/512	60/300
St. Louis	40/10240	0/512	8/1000	St. Louis	20/10240	4/512	30/1000
Rio Bravo	40/5120+			Rio Bravo	0/5120+		
Ilheus	40/5120+			Ilheus	0/5120		
Dengue 2	20/2560			Dengue 2	0/2560		
Modoc	40/5120+						
JBE	40/5120+						
Bussuquara	0/320						
Banzi	0/2560						

* Heterologous/homologous

NT: serum dilution plaque-reduction neutralization titers.

In two separate cross-neutralization studies, one involving 42 flaviviruses, Powassan virus could not be placed in a complex [35] ; while the second study concerned 65 flaviviruses and placed Powassan in a complex consisting of 13 other primarily tick-borne flaviviruses [36] .

Section VI - Biologic Characteristics

Virus Source (all VERTEBRATE isolates)
Brain (M)(LV), blood (LV), spleen (LV), liver (LV), kidney (LV),

Lab Methods of Virus Recovery (ALL ISOLATIONS)
Newborn mice

Cell system (a)	Virus passage history (b)	Evidence of Infection						
		CPE			PLAQUES			Growth Without CPE
		Day (c)	Extent (d)	Titer TCD50/ml (e)	Day (c)	Size (f)	Titer PFU/ml (e)	+/- (g)
Rhesus monkey kidney(PC)	SMB 2		No CPE					
Hog kidney(PC)	SMB 10	7	Necrosis	6.0**				
Chick embryo (PC)	SMB6-10	2	No CPE	6.0				
LLC-MK2(CL)	LLC-8	5	Necrosis	6.0				
Vero(CL)	P-9				15	1 mm	4.6** (34)	
LLC-MK2(CL)					7	2 mm	7.7 (34)	
PS (CL)					6	Plaques	8.7 (36)	

** Expressed in dex

Section VII - Natural Host Range (Additional text can be added below table)

Vertebrate (species and organ) and arthropod	No. isolations/No. tested	No. with antibody/No. tested Test used	Country and region
Man	1/1	1/1,008 NT	Powassan, Ontario, Canada (1, 3)
Man	0/174	0/174 NT	Black Hills, S.Dakota, USA (4)
Man		4/1,936 NT	British Columbia, Canada (5)
Man	1/1 HI,NT	Sherbrooke, Quebec, Canada (20)	
Man	1/1	4/4 HI,CF	Upstate New York, USA (21, 26)

Man		1/1 HI,CF	Pennsylavania, USA(25)
Marmota monax (woodchuck)	2/708	518/1,709 NT	Powassan, Ontario, Canada (6-9)
M. monax	3		Upstate New York, USA (15)
M. flaviventris		97/684 NT	British Columbia, Canada (11-14)
Tamiasciurus hudsonicus (squirrel)	1/252	42/303 NT	Powassan, Ontario, Canada (10)
T. hudsonicus		92/449 HI	British Columbia, Canada (11-14)
Peromyscus sp. (deer mice)	1/49	24/133 NT	Black Hills, S.Dakota, USA (4)
Microtus sp. (meadow mice		15/113 NT	
Eutamias sp. (chipmunk)		9/119 NT	
Foxes	1	8/9 NT	Upstate New York, USA (16)
Racoons, M. mephetis (spotted skunk)		4/22 NT	Upstate New York, USA (16)
Ixodes marxi ticks	1/58		Powassan, Ontario, Canada (10)
I. cookei	18/279		Powassan, Ontario, Canada (7-9)
I. cookei	2		Upstate New York, USA (15)
I. cookei	1		Berkeley, Massachusett USA (23)
I. spinipalpus	1/334		Black Hills, S.Dakota, USA (4)
Dermacentor andersoni	1/175		
D. andersoni	1/100		Weld Co., Colorado, USA (24)
Haemaphysalis neumanii	1/16,000		So. Primorye region, USSR (22)
Spotted skunk (blood)	1;1		CA (18); Berkeley, MA, USA (23)
Man (blood)	1	4.3%/117	Primorski krai, USSR (30)
Anopheles hyrcanus	5		USSR (33)
Aedes togoi	2		

Section VIII - Susceptibility to Experimental Infection (include viremia)

Experimental host and age	Passage history and strain	Inoculation Route-Dose	Evidence of infection	AST (days)	Titer log10/ml
Mice (nb)	SMB 2-6	ic 0.02	Encephalitis, death (1,9)	5	9.0
Mice (nb)		ip 0.02	Encephalitis, death	5	9.0
Mice (nb)		sc			
Mice (wn)		ic 0.03	Encephalitis, death	7	9.0
Mice (wn)		ip 0.03	Encephalitis, death	8	9.0
chickens (1-3 day)	SMB 2	sc 0.03	Viremia, no deaths		6.0
hamsters (2-4 mo)		sc 0.03	Viremia, no deaths		3.3
rabbits (1 year)		sc 0.03	Viremia, no deaths		3.0
eggs (11 day)		CAM 0.05	None		
eggs (11 day)		ys 0.05	None		
Marmota (woodchuck)	SMB 3-4	sc	Viremia, asymptomatic (17)		
goat lactating (ad)		im	Virus secreted in milk after 7-15 days (27)		
Macaca mulatta monkeys	LB, P-40		Encephalitis, death (39)		

Section IX - Experimental Arthropod Infection and Transmission

Arthropod species & virus source (a)	Method of Infection log10/ml (b)		Incubation period (c)		Transmision by bite (d)		Assay of arthropod, log10/ml (e)		
	Feeding	Injected	Days	°C	Host	Ratio	Whole	Organ	System
Dermacentor andersoni larvae fed on rabbits rendered viremic by intravenous injection of Powassan virus (19)	3.0		56	21	guinea pig, hamster		3.0	sal.gl. 3.0	

Section X - Histopathology

Character of lesions (specify host)
Neuronophagia, glial knots, perivascular cuffing with lymphocytes in brain and spinal cord of fatal human case and in weaned mice moribund with infection

Inclusion Bodies — Intranuclear

Organs/Tissues Affected
Brain and spinal cord

Category of tropism
Neurotropic

Section XI - Human Disease

In Nature
Significant

Residual

Death
Significant

Subclinical

Overt Disease
Reported

Clinical Manifestations
Fever (S), headache, (S), prostration (S), stiff neck (S), CNS signs (including encephalitis (S), CNS Pleocytosis (S), spastic paresis

Number of Cases
20 (1,20,21,25,26,29,32)

Category (i.e. febrile illness, etc.)
Encephalitis

Section XII - Geographic Distribution

Known (Virus detected)
Canada: Ontario (1,8,10); USA: Upstate New York (15,16,21), South Dakota (4), Colorado (20), California (18), Massachusetts (23); USSR (22)

Suspected (Antibody only detected)

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Remarks