野生動物疫苗策略與應用

從免疫避孕到傳染性腫瘤防治

Wild Animal Vaccine Strategies and Applications
From Immunocontraception to Transmissible Cancer Control

章愛梅 助理教授

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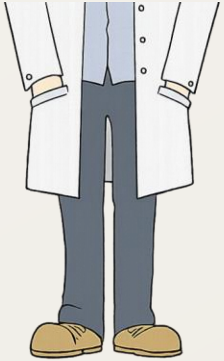

About the Speaker

章愛梅 AiMei Chang
Research Interests: Wildlife Infectious Diseases, Immunology, Vaccine Development

2011 - 2016
DVM

2017 - 2023
PhD

2023 - 2024
Postdoc

2025 - Present
Assistant Professor

14
SCI Publications

11
First or Co-first Author Papers

Wildlife Vaccines in Conservation Medicine

- Disease prevention
- Population management
- Non-lethal control
- Endangered species protection
- Ecosystem stability

Types of vaccines

nature reviews immunology

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Review Article | Published: 22 December 2020

A guide to vaccinology: from basic principles to new developments

Type of vaccine		Licensed vaccines using this technology	First introduced
Live attenuated (weakened or inactivated)		Measles, mumps, rubella, yellow fever, influenza, oral polio, typhoid, Japanese encephalitis, rotavirus, BCG, varicella zoster	1798 (smallpox)
Killed whole organism		Whole-cell pertussis, polio, influenza, Japanese encephalitis, hepatitis A, rabies	1896 (typhoid)
Toxoid		Diphtheria, tetanus	1923 (diphtheria)
Subunit (purified protein, recombinant protein, polysaccharide, peptide)		Pertussis, influenza, hepatitis B, meningococcal, pneumococcal, typhoid, hepatitis A	1970 (anthrax)
Virus-like particle		Human papillomavirus	1986 (hepatitis B)
Outer membrane vesicle	Pathogen antigen; Gram-negative bacterial outer membrane	Group B meningococcal	1987 (group B meningococcal)
Protein–polysaccharide conjugate	Polysaccharide; Carrier protein	*Haemophilus influenzae* type B, pneumococcal, meningococcal, typhoid	1987 (*H. influenzae* type b)
Viral vectored	Viral vector; Pathogen gene; Viral vector genes	Ebola	2019 (Ebola)
Nucleic acid vaccine	DNA; RNA; Lipid coat	SARS-CoV-2	2020 (SARS-CoV-2)
Bacterial vectored	Pathogen gene; Bacterial vector	Experimental	–
Antigen-presenting cell	Pathogen antigen; MHC	Experimental	–

Immunocastration vaccine

Ph.D. thesis: Development of novel GnRH-based vaccine and its efficacy in various mammal species

vaccines MDPI

Article

Effects of a Recombinant Gonadotropin-Releasing Hormone Vaccine on Reproductive Function in Adult Male ICR Mice

Ai-Mei Chang [1,2], Chen-Chih Chen [2,3,4,*], Ding-Liang Hou [4], Guan-Ming Ke [1,2,4,5] and Jai-Wei Lee [1,6,*]

Contents lists available at ScienceDirect

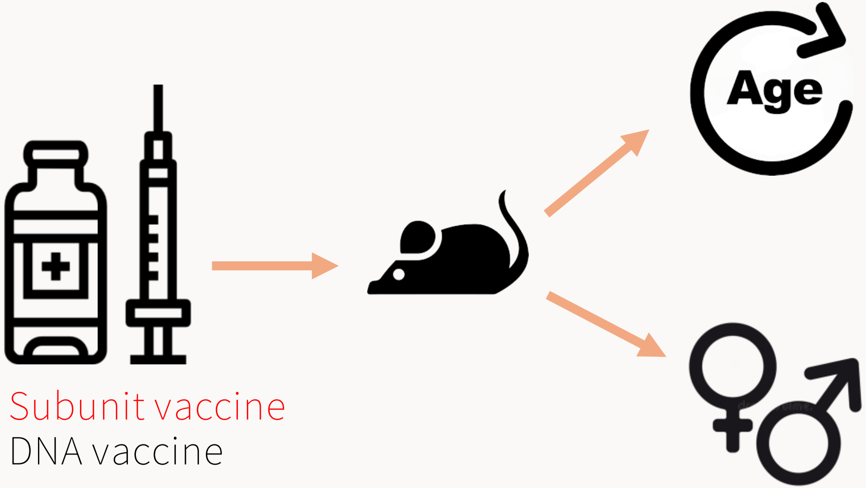
Vaccine

journal homepage: www.elsevier.com/locate/vaccine

ELSEVIER

Effects of a novel recombinant Gonadotropin-Releasing Hormone-1 vaccine on the reproductive function of mixed-breed dogs (*Canis familiaris*) in Taiwan

Ai-Mei Chang [a,1,6], Chen-Chih Chen [a,2,3,6,*], Jai-Wei Lee [a,b,1,5,7,*], Ding-Liang Hou [a,3], Hsiao-Hui Huang [a,5], Guan-Ming Ke [a,1,2,3,4,6]



Subunit vaccine

DNA vaccine

Field test

Volunteer households

KT National Park

LAB

1. GnRH-based recombinant vaccine
2. Test vaccine efficacy of different age/ sex
3. Fertility inhibition
4. Development of non-invasive detection method

The Thai Journal of Veterinary Medicine

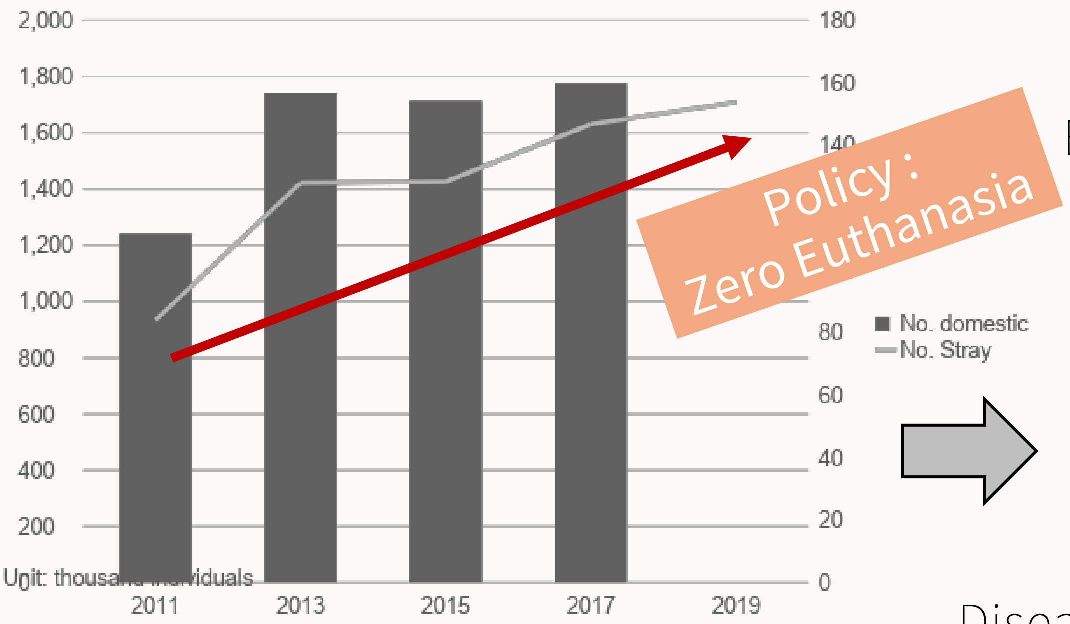
Volume 55
Issue 1 *January - March*

Article 5

March 2025

Assessing the feasibility of microneedle patches for GnRH immunocontraception in mixed-breed dogs (Canis familiaris)

Overpopulation of stray animals in Taiwan



Biting

Barking

Traffic accidents

Disease transmission

Threaten to native wildlife species

(Butler et al. 2004)

Population Control Methods

RECOMMENDED

Culling & Barrier

Traditional lethal or physical containment methods.

Chemical & Hormonal

Pharmacological interventions for reproduction control.

Surgical Sterilization

Permanent surgical methods to prevent breeding.

Immunocastration

Advanced vaccine-based non-lethal population management.

Comparison of reproductive control methods

Surgery

- Time consuming
- High invasiveness
- Professional skill required
- Expensive
- Difficult to execute on a large scale

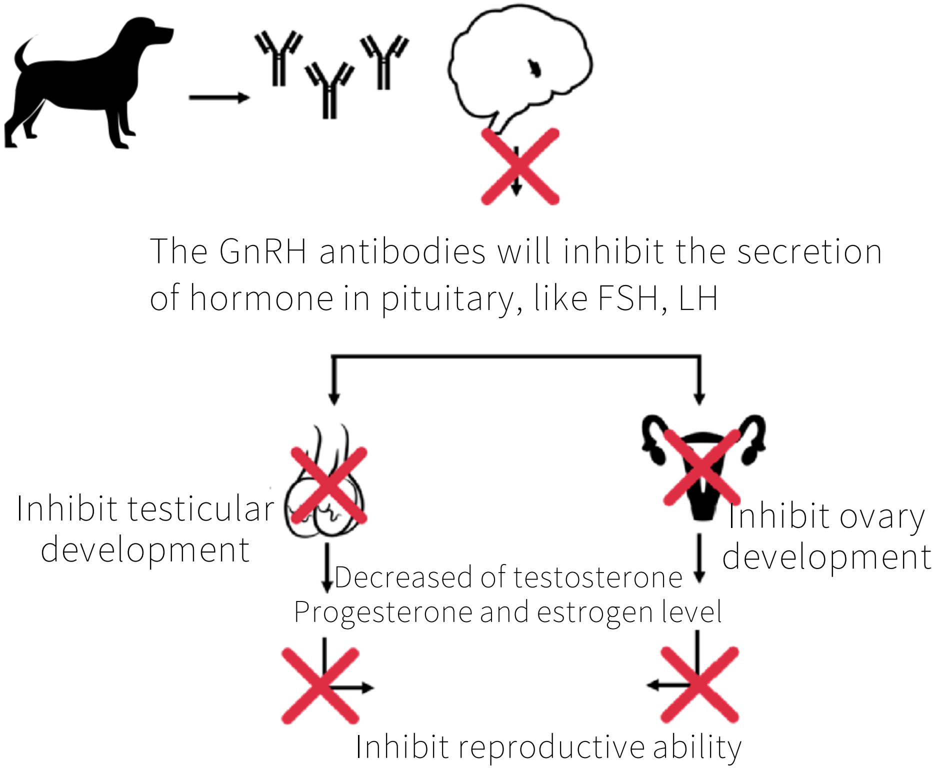
Immunocastration vaccine

- Quick
- Low invasiveness
- No need for veterinary expertise
- Lower cost
- Feasibility for large-scale execution
- Different administration methods

How does immunocastration work?

Gonadotropin-releasing hormone, GnRH

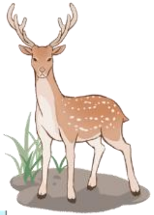
It is the primary central regulator of individual reproduction and also the most commonly used as the neutralization target for vaccines.



Overpopulation of Sika Deer

Timeline

- 1895: Extinction
- 1994: Reintroduced to wild
- Today: Overabundance!!



Impact & Damage

Forestry damage

Crop damage

Vehicle collision

Standard Approaches:

- Hunting
- Trapping
- Lethal me

Overpopulation of Sika Deer

Timeline

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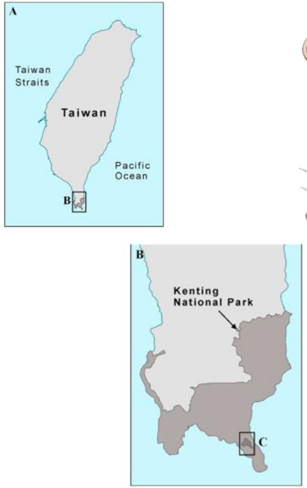
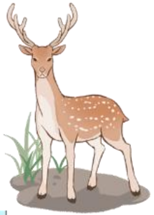




Impact & Damage

Forestry damage

Crop damage

Vehicle collision

New way for population control

- Large scale
- Safe
- Less-invasive
- Non-lethal

Challenges in Wildlife Vaccination

- Field logistics require specialized equipment and mobile teams.
- Capturing wildlife for vaccination is labor-intensive and unpredictable.

Booster Limitations → Single-shot

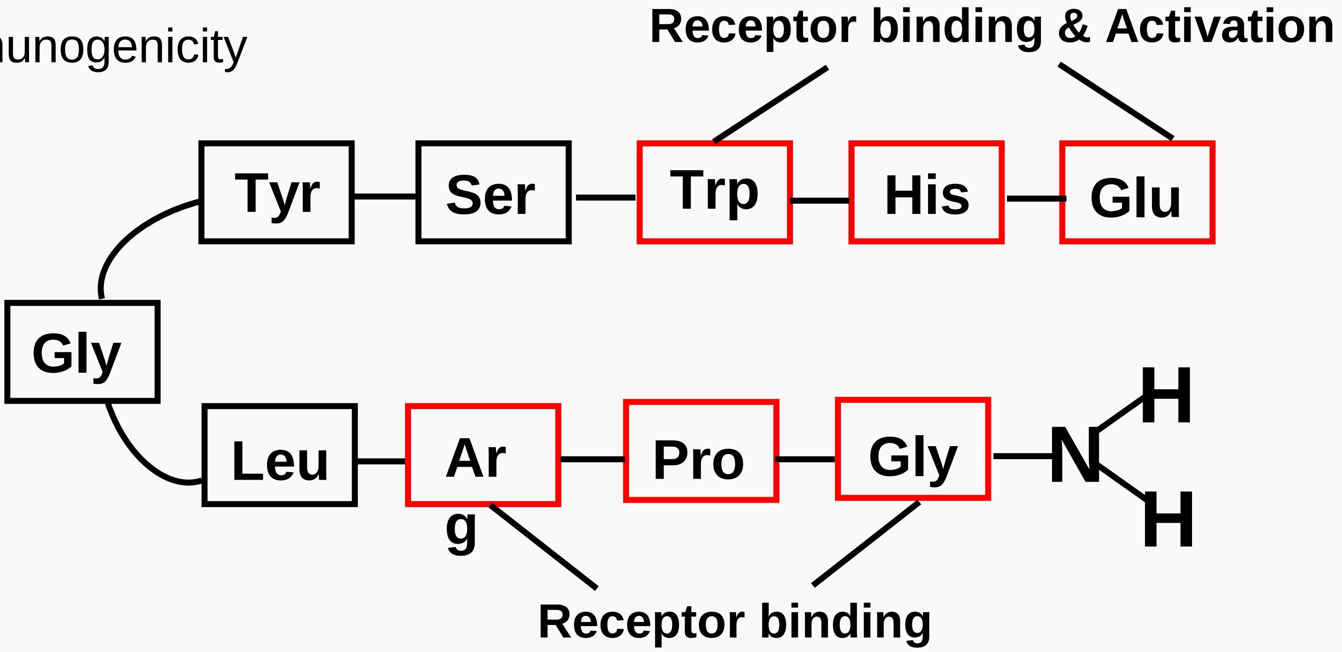
Monitoring Challenges → Non-invasive Monitoring

Difficult Capture → Remote Delivery Systems

Limitation of GnRH

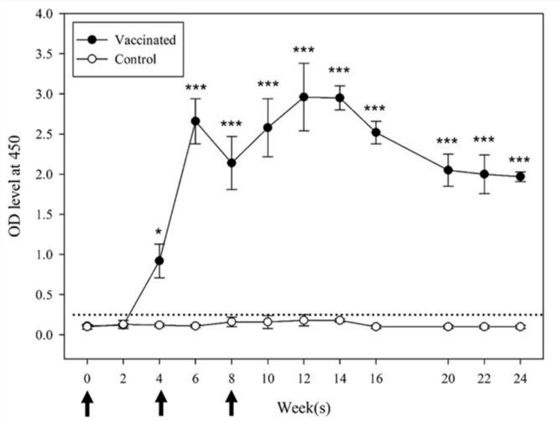
- Decapeptide
- Self-antigen
- Poor immunogenicity

- Repeat Antigen Sequences
- Danger Signal Incorporation
- Potent Adjuvant Systems

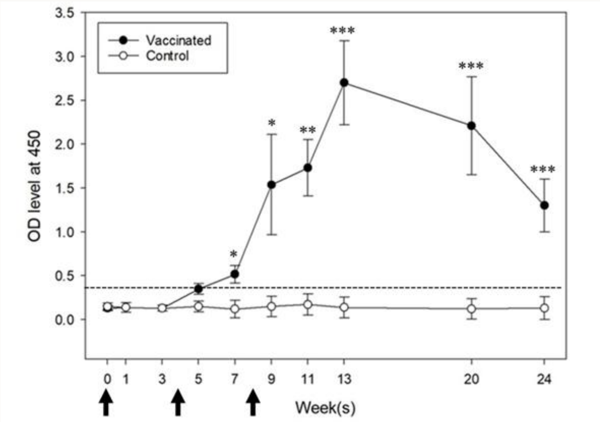


Induced Specific Anti-GnRH Antibody

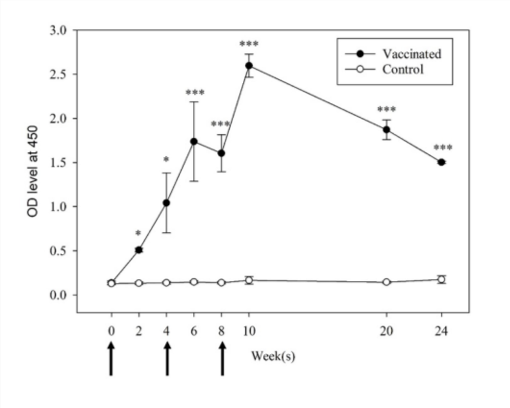
A. Subadult (Male)



B. Adult (Male)



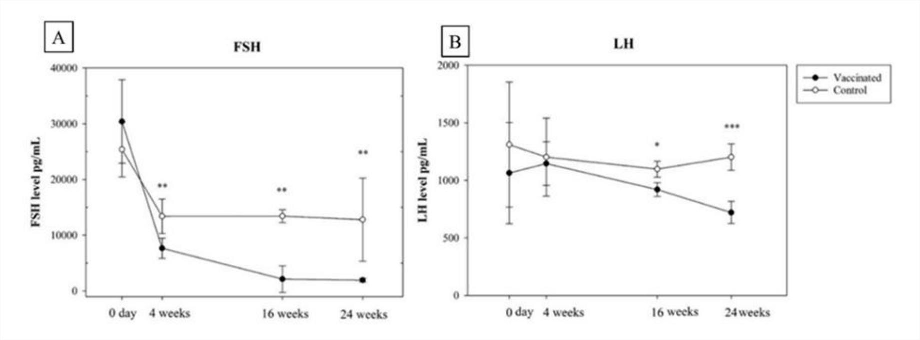
C. Subadult (Female)



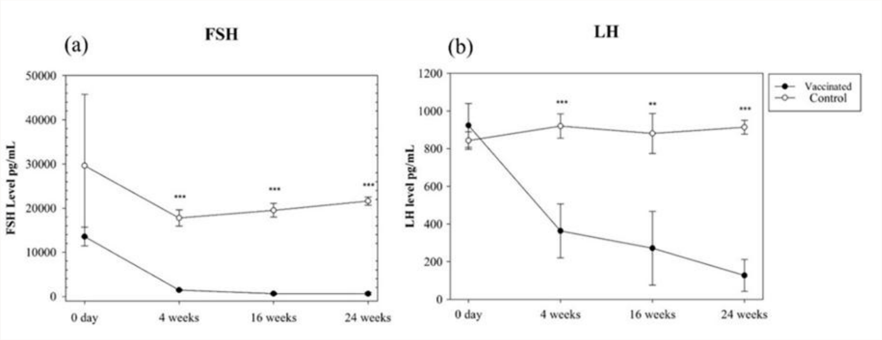
- Similar increasing pattern across groups
- Highest antibody level reached at week 10 to 14
- Maintenance of antibody levels observed until week 24

Decreasing of LH/FSH/ testosterone concentrations

♂ Subadult



♂ Adult

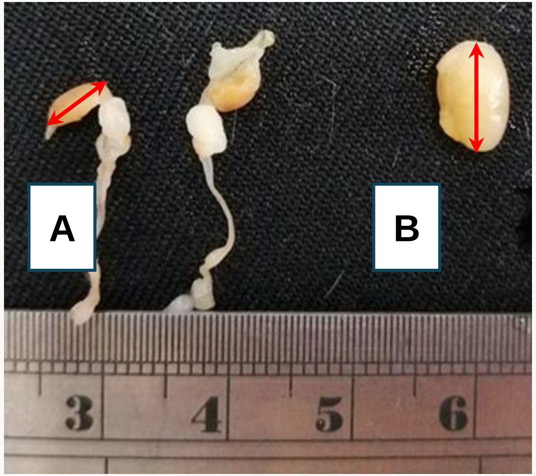


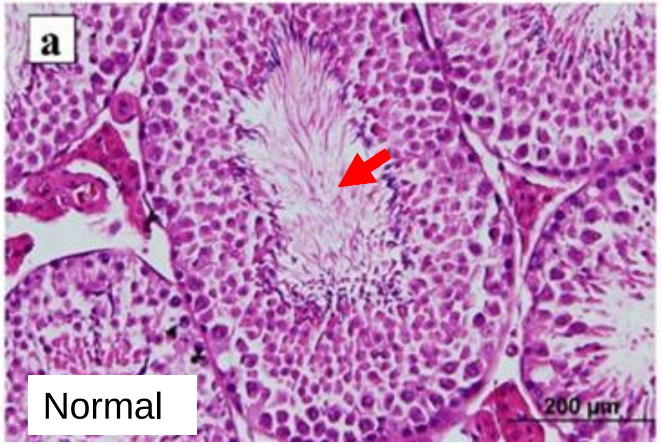
- The levels of all hormones decreased significantly
- Consistent trend observed across both subadult and adult groups

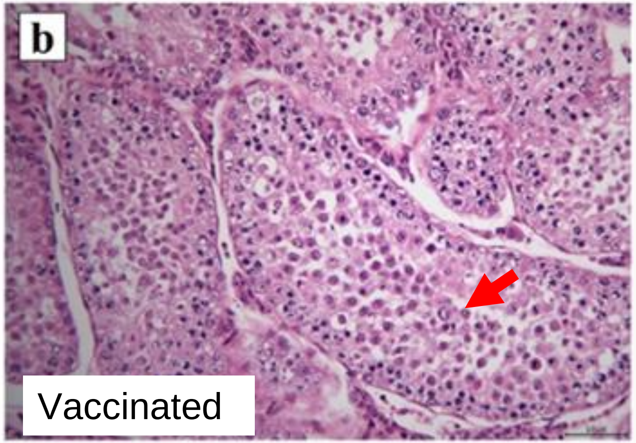
Atrophy of testis

A. Vaccinated group

B. Control group



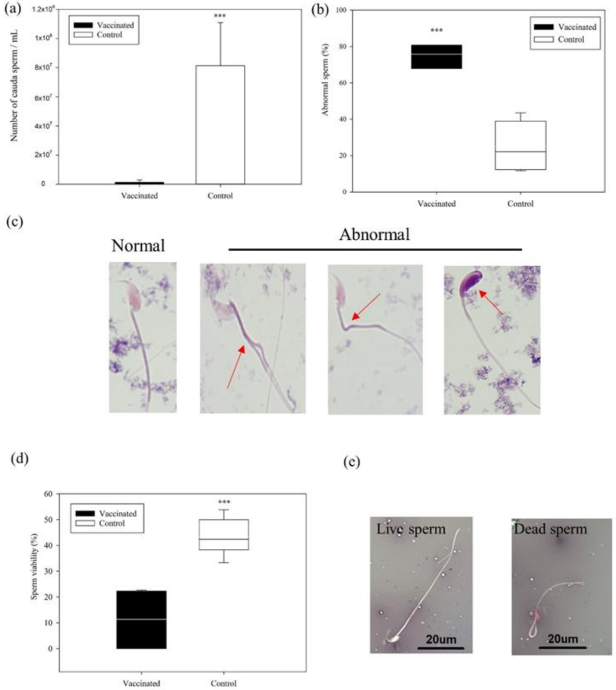




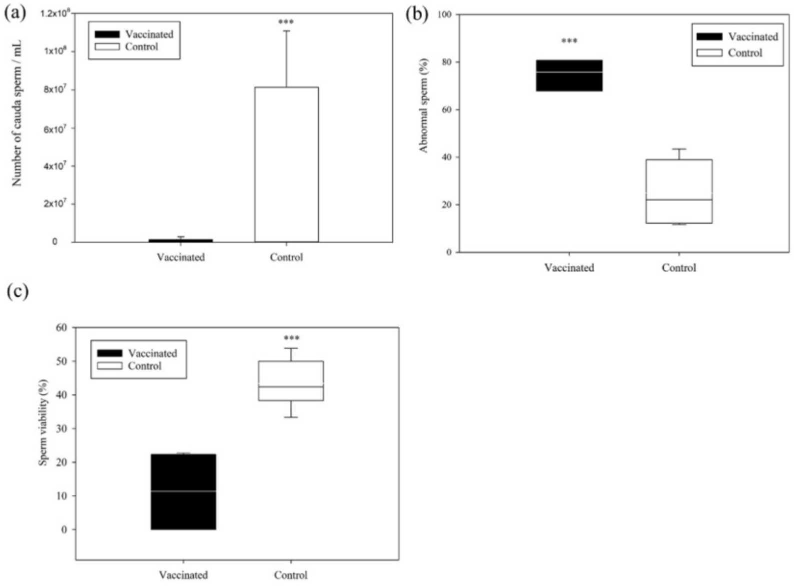
- Few spermatozoa with no visible lumen in vaccinated mice
- dark stained nuclei with round, enlarged size were appeared

Poor sperm quality (count, abnormality, viability)

♂ Subadult

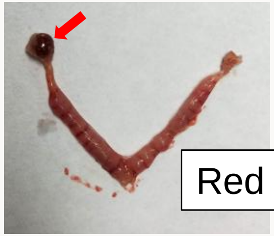


♂ Adult



Mating test

Male	Female	Pregnancy rate(%)	Number of pups
Immunized at sexual mature male mice			
Control(4)	Control(4)	75%	15 (16/14/15)
Vaccinated (4)	Control(4)	25%	12
Control(4)	Vaccinated (4)	25%	0 (Red cyst)
Vaccinated (4)	Vaccinated (4)	0%	0



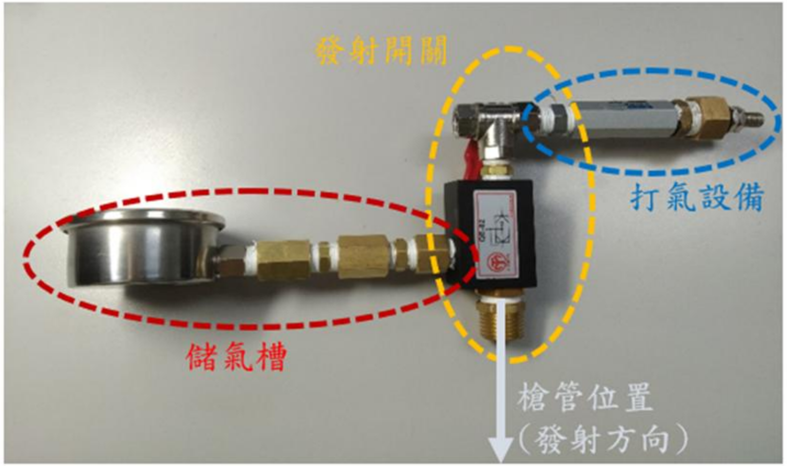
Red cyst was noticed in vaccinated mice

Highly similar of GnRH sequence between each species

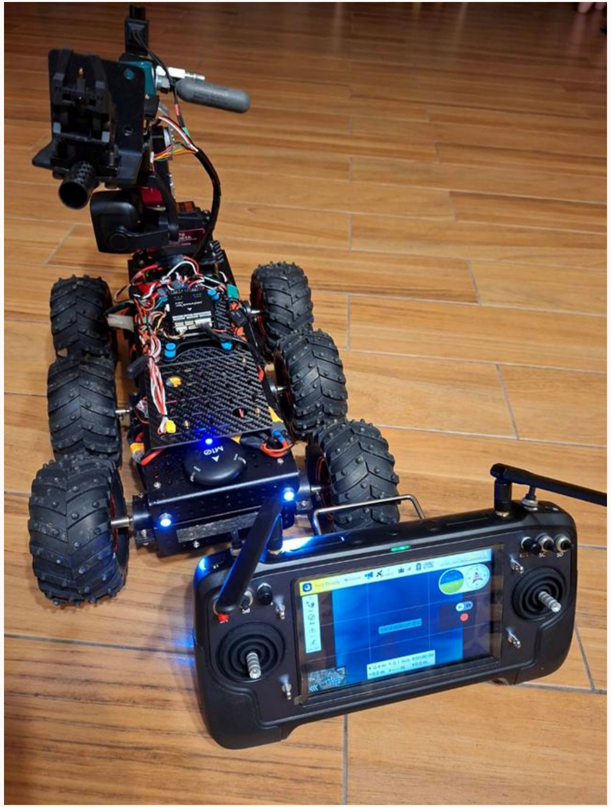
Species	GnRH-I sequence
Human	EHWSYGLRPG
Rhesus monkey	EHWSYGLRPG
Deer	EHWSYGLRPG
Dog	EHWSYGLRPG
Mice	EHWSYGLRPG
Guinea pig	EYWSYGVRPG
Chicken	EHWSYGLQPG

Self-built aerodynamic launch system for drones

野生動物保育研究所
陳貞志老師



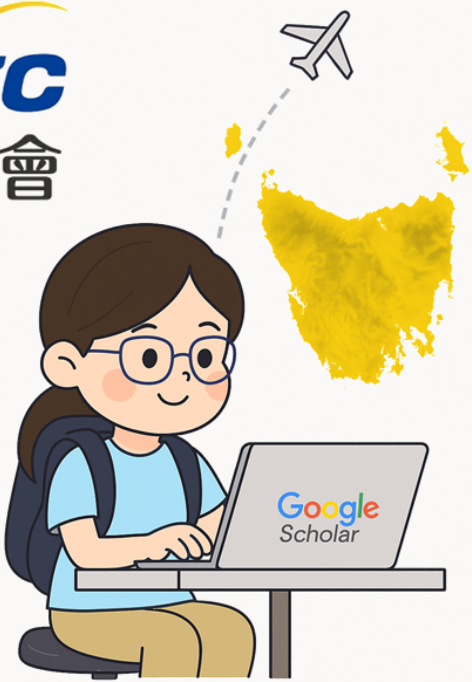
Unmanned Ground Vehicle-Based Injection System



野生動物保育研究所
陳貞志老師

A Journey Across 7,900 Kilometers

國科會



Dr. Andrew Flies

Associate Professor of Immunology

Menzies Institute for Medical Research,

University of Tasmania

UNIVERSITY of TASMANIA | MENZIES Institute for Medical Research

Devil Team

- Comprehensive research unit

Tasmanian devil

Sarcophilus harrisii

The Tasmanian devil is a carnivorous marsupial of the family Dasyuridae.

It was once native to mainland Australia and is now found in the wild only on the island state of Tasmania.

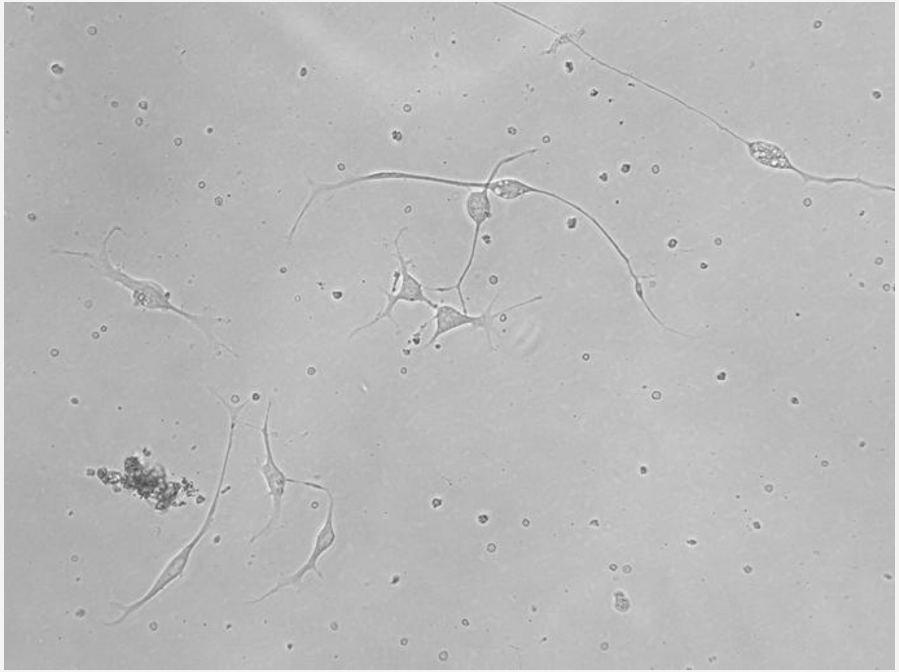
What is Devil Facial Tumour Disease (DFTD)?

Key Characteristics

- A transmissible cancer affecting Tasmanian devils
- First identified in 1996
- Causes large tumors on the face and mouth

DFTD Characteristics

- Transmitted through biting (common in social interactions)
- 100% fatal without intervention
- Two known strains: DFT1 and DFT2



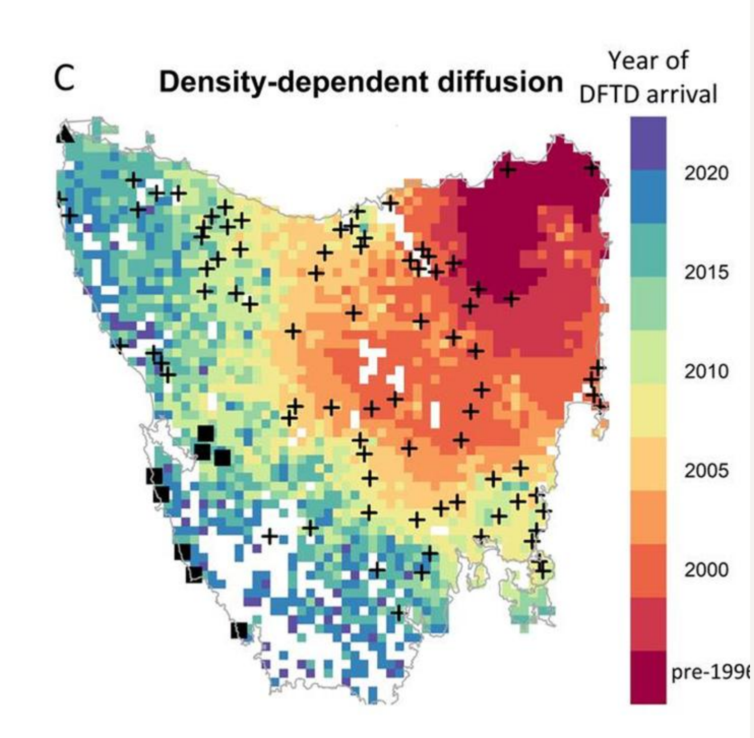
Spread of DFTD Across Tasmania

mapShows DFTD spread in Tasmania since 1996

paletteColors indicate year of disease arrival

model_trainingBased on density-dependent diffusion model

speedFaster spread in high-density devil areas



Why Can DFTD Escape the Immune System?

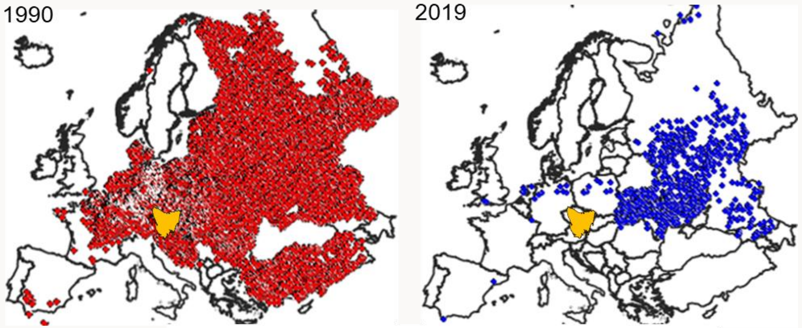
- Loss of MHC-I expression
- Reduced tumour recognition
- Immune evasion
- Failure of cytotoxic T-cell response

DFTD Vaccine Strategies

- IFN-γ-treated DFT tumour cells
  - Whole-cell tumour vaccines
- Adenoviral vector vaccines
  - Tumour-associated antigens
- Neoantigen-based vaccine development

Oral Bait Vaccines (OBVs)

- Remote vaccine delivery
- Wildlife-friendly strategy
- Population-level vaccination
- Reduced handling stress



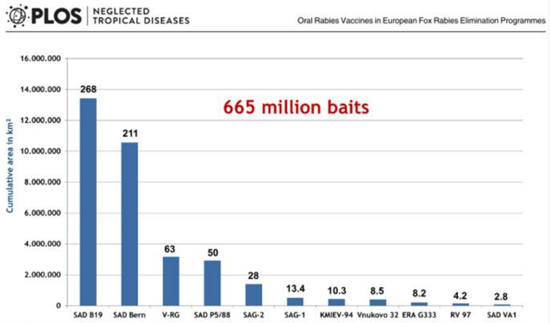
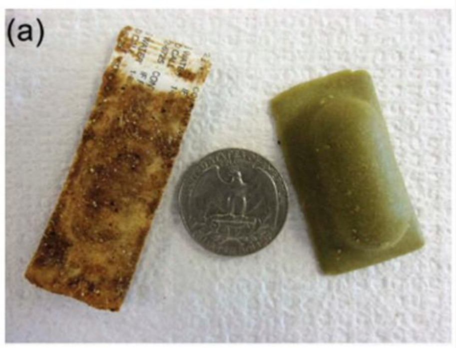


Fig 3. Number of individual vaccine doses disseminated in ORV programmes in Europe between 1978 and 2014. Approximate calculation of the numbers of vaccine doses of different oral vaccine strains against rabies over the past four decades (x axis) based on the cumulative area ever vaccinated with a single vaccine bait (y axis) and an assumed average bait density of 20 baits/km^2.

doi:10.1371/journal.pntd.0003953.g003



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RESEARCH PAPER
https://doi.org/10.1071/WR22070
WILDLIFE RESEARCH

Evaluation of oral baits and distribution methods for Tasmanian devils (*Sarcophilus harrisii*)†

Sean Dempsey[A,B], Ruth J. Pye[A], Amy T. Gilbert[C], Nicholas M. Fountain-Jones[B], Jennifer M. Moffat[A], Sarah Benson-Amram[D], Timothy J. Smyser[C] and Andrew S. Flies[A,*]

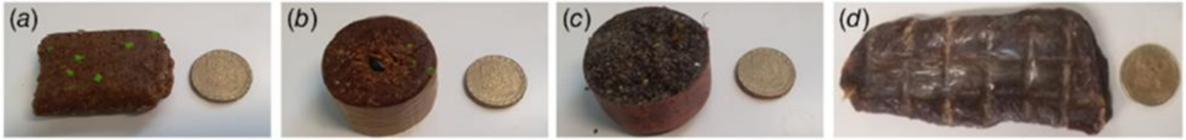
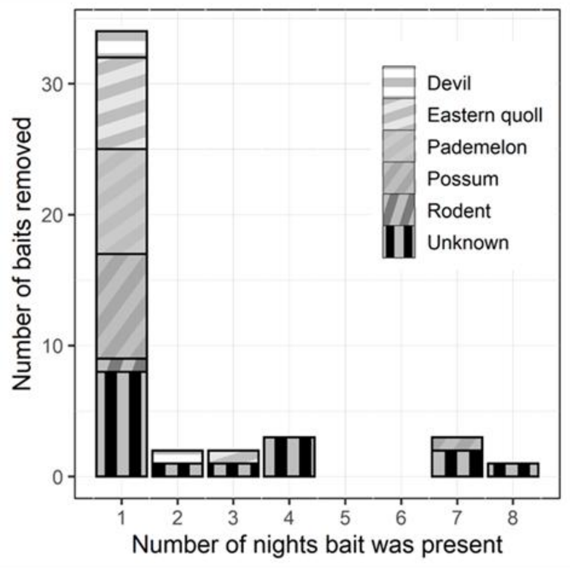


Fig. 2. (*a*) Ruminant meat-based, (*b*) fish-based and (*c*) fish-flavoured cereal-based, and (*d*) dried kangaroo meat baits. A 25-mm coin is shown for scale.



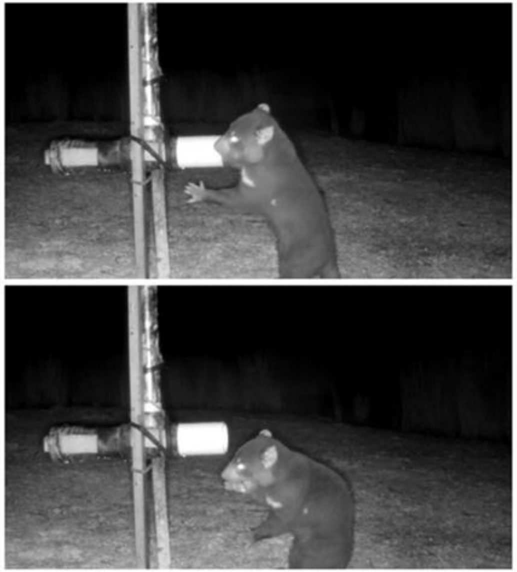
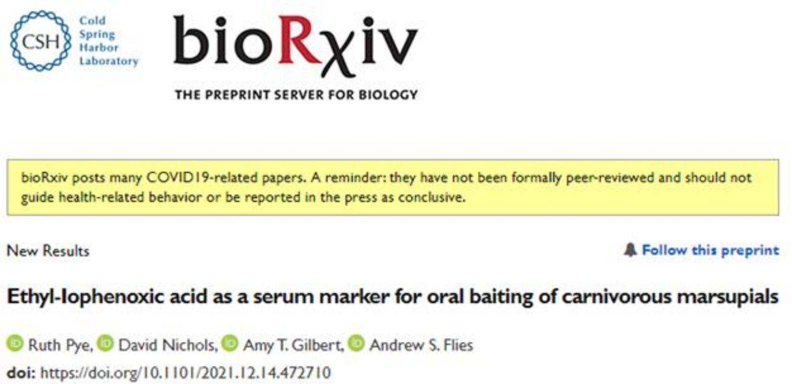


Table 5. Dispenser interactions.

Species or group	Visits	Dispenser interactions	Bait retrievals	Suspected retrievals
Macropods	94	20	0	0
Brushtail possum	29	5	1	0
Eastern quoll	41	39	8	0
No ID	9	0	0	0
Tasmanian devil	33	21	11	2
Other marsupials	4	0	0	0
Rabbit	3	0	0	0
Cat	14	5	0	0
Dog	2	0	0	0
Rodents	41	22	1	1
Total	270	112	21	3

Total amounts of visits, dispenser interactions, bait retrieval and suspected bait retrieval by animals/categories of animals from 33 bait-exposure nights (BENs) across three sites.

Serum biomarker to monitor bait consumption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THE PREPRINT SERVER FOR BIOLOGY

bioRxiv posts many COVID19-related papers. A reminder: they have not been formally peer-reviewed and should not guide health-related behavior or be reported in the press as conclusive.

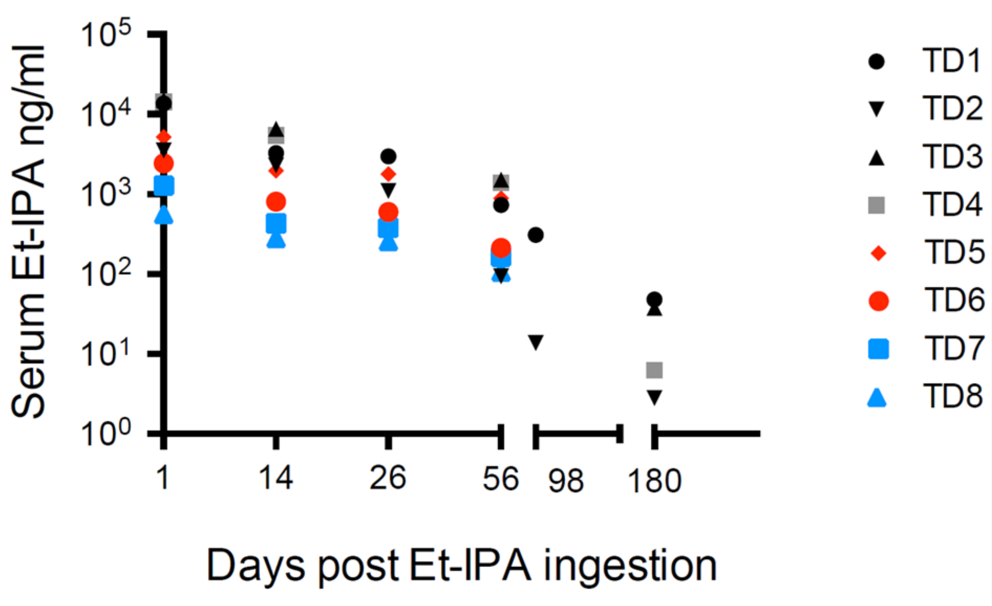
New Results

Follow this preprint

Ethyl-Iophenoxic acid as a serum marker for oral baiting of carnivorous marsupials

Ruth Pye, David Nichols, Amy T. Gilbert, Andrew S. Flies

doi: https://doi.org/10.1101/2021.12.14.472710



Wildlife medicine + AI + IoT

Remote trap monitoring

Real-time notifications for effective wildlife capture management.

LoRaWAN networks

Long-range, low-power connectivity for remote conservation areas.

Behavioral tracking

Detailed analysis of animal movement and interaction patterns.

AI-assisted surveillance

Automated identification and threat detection using AI models.

Vaccines Are More Than Just an Injection

Conservation Medicine

- Disease prevention and population management
- Immunocontraception in wildlife control
- Cancer immunology and DFTD vaccines
- Integration of immunology, ecology and technology

Delivery & Monitoring

• Oral bait vaccines and remote delivery systems

• Non-invasive monitoring in wildlife research

Welcome to Join Us!

Any Questions?

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