REPRODUCTIVE PHYSIOLOGY OF HIGH-PRODUCING DAIRY CATTLE

Postpartum ovulation and estrous expression in relation to subsequent fertility

For presentation at Mahanakorn University of Technology (March 21, 2016)

1. Physiology vs. management factors
2. Resumption of ovarian activity and the fate of follicular cysts
3. Resumption of estrous activity and relapse back into anestrus
4. Indices for fertility and automated estrous detection methods
5. Future aspects

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1. OVERVIEW FOR DAIRY REPRODUCTION

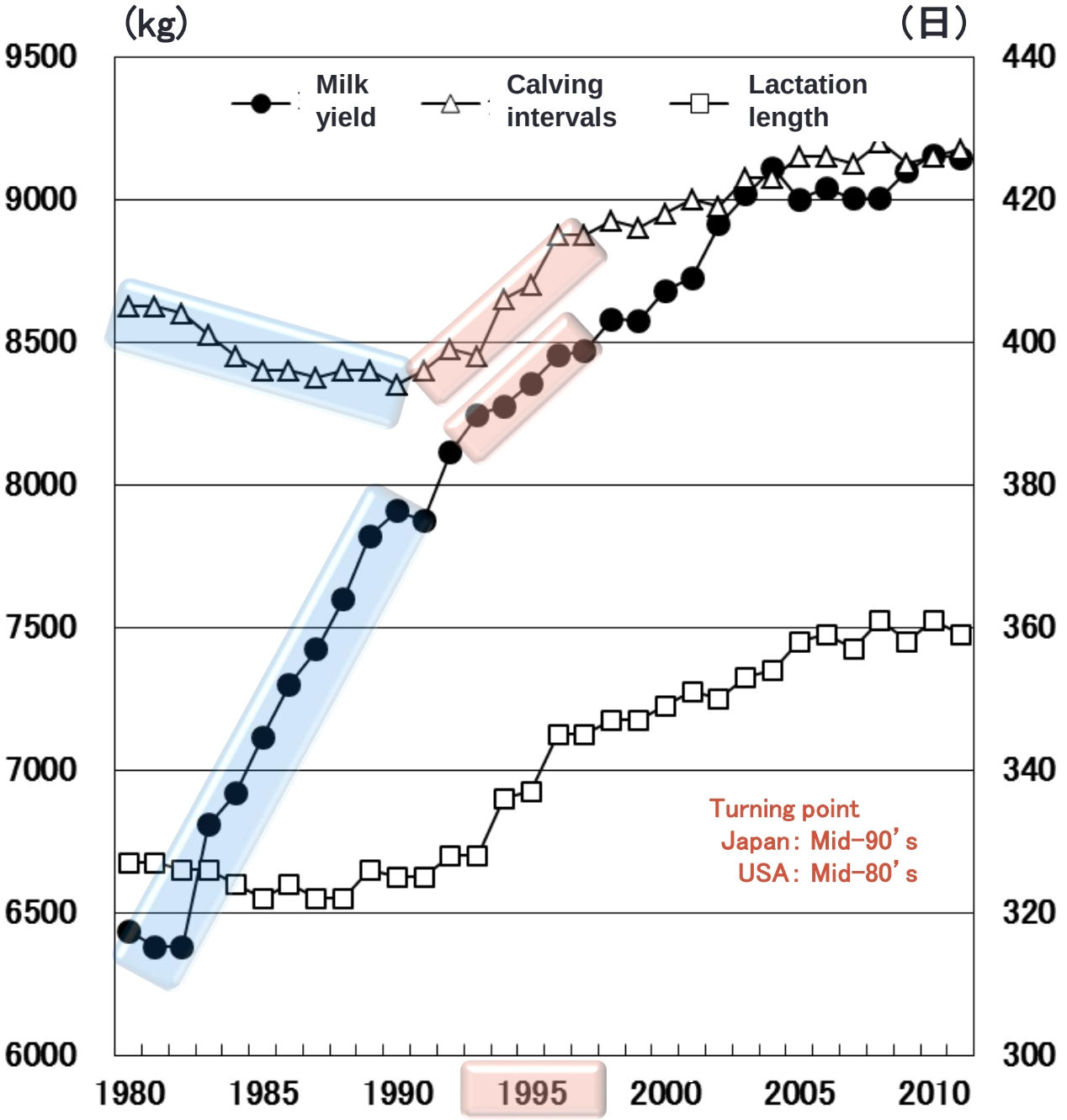
Changes in the dairy management and dairy cattle physiology

Declining fertility in dairy industry

- Fertility
  - Heat manifestation and detection
  - Pregnancy rates
  - Calving intervals
  - Culling for infertility
- Optimum calving intervals depend on
  - Milk production level
  - Lactation curve
- Genetic improvement for milk production caused low fertility?

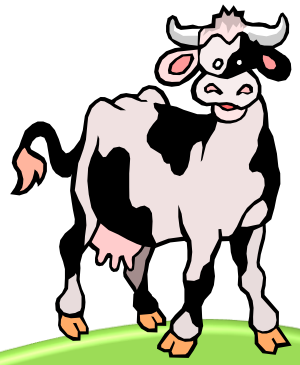
Trends during last 30 years

Year	Milk yield	Calving interval
1993	8,244	398
1994	8,273	406
1995	8,355	408
1996	8,451	415
1997	8,469	415



Data from Hokkaido region, Japan

Herd level declining in dairy cattle fertility

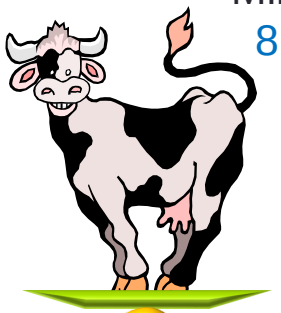


60's – 70's Dairy cows
Milk yield : 4,000 - 6,000kg

Sufficient feed intake
Individual management

High Health status
Good fertility

Modern dairy cows
Milk yield:
8,000 - 12,000kg



Reproductive problem
- Endocrine abnormality
- Ovarian dysfunction
- Endometritis
- Embryonic loss

Production disease
Milk fever
- Ketosis
- Displaced abomasum
- Hoof diseases

Changed management systems
Expanding herd size
Insufficient feed intake
(Overfed concentrate)

Low productivity
Reproductive disorder

Higher production level and expanding herd size drastically changed the nutritional and environmental statuses of dairy cattle

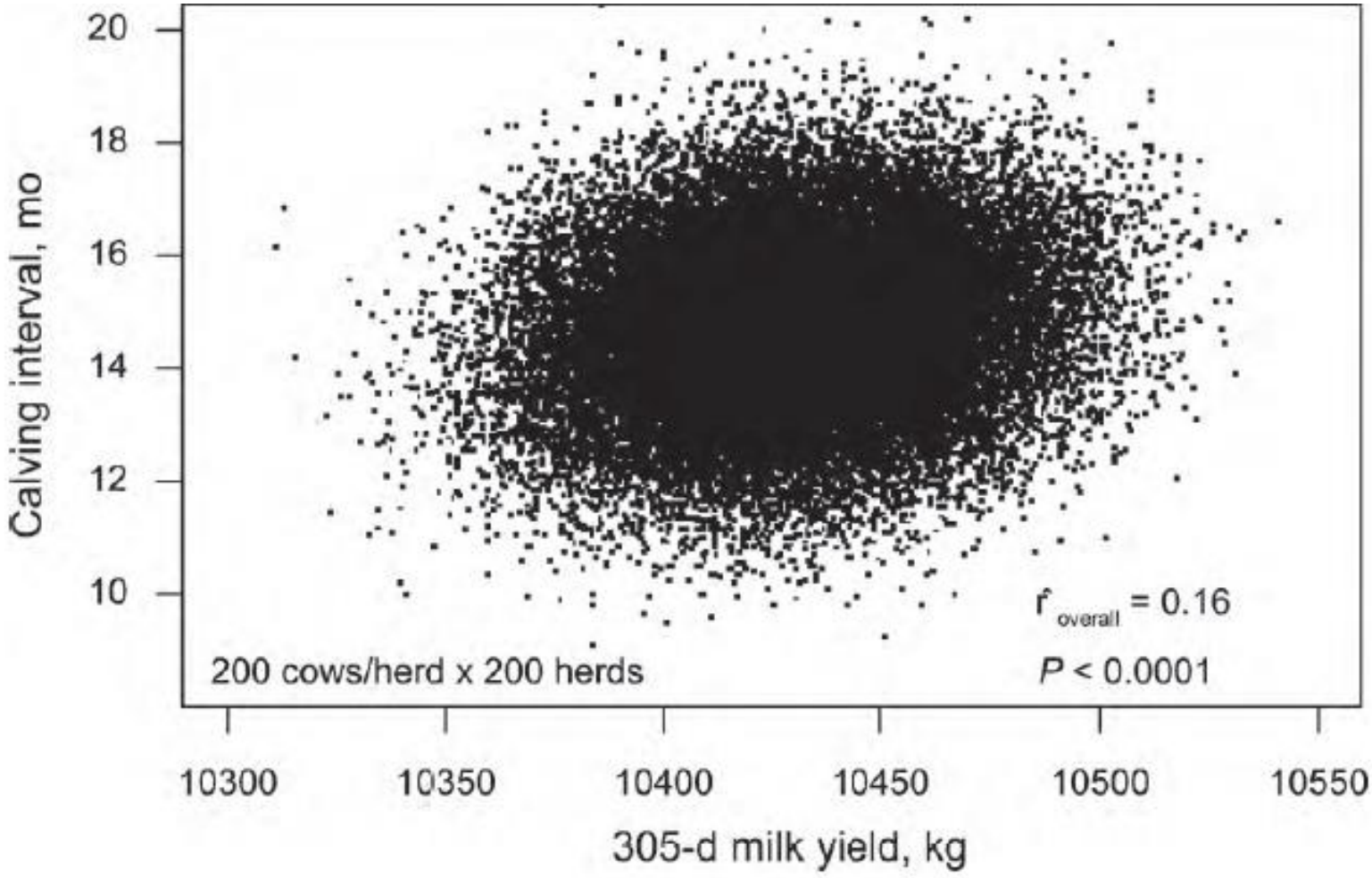
Production and reproduction

J. Dairy Sci. 95:5461–5475
http://dx.doi.org/10.3168/jds.2012-5564

Invited review: **Milk production and reproductive performance: Modern interdisciplinary insights into an enduring axiom**

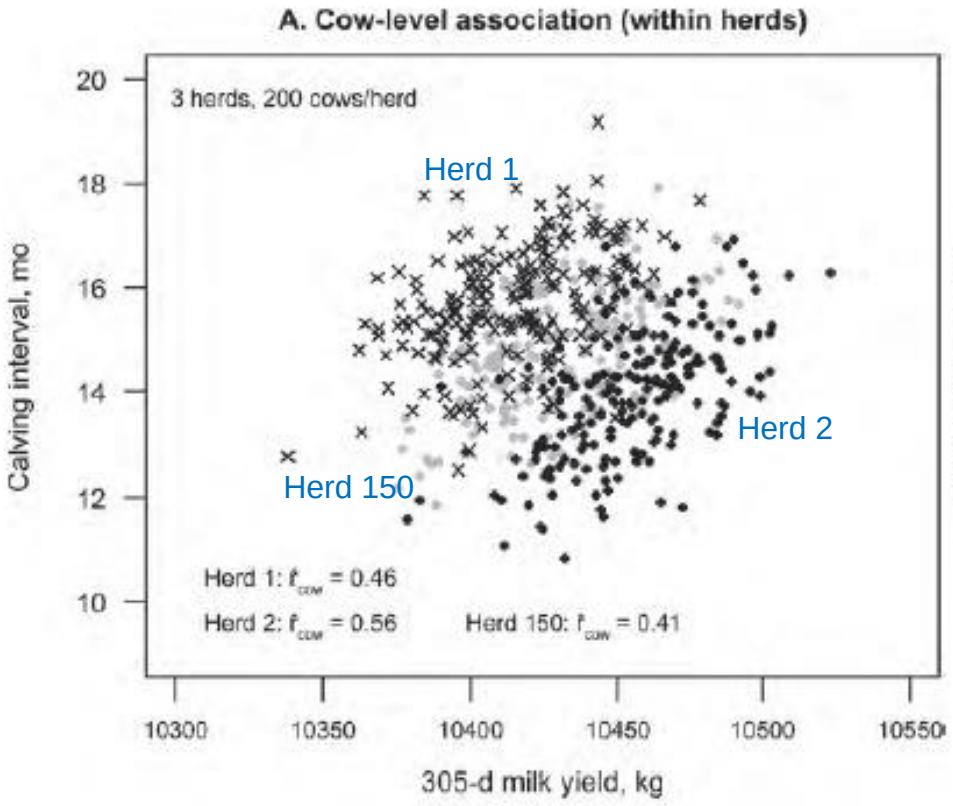
N. M. Bello,*[1] J. S. Stevenson,† and R. J. Tempelman‡

200 herds
40,000 cows



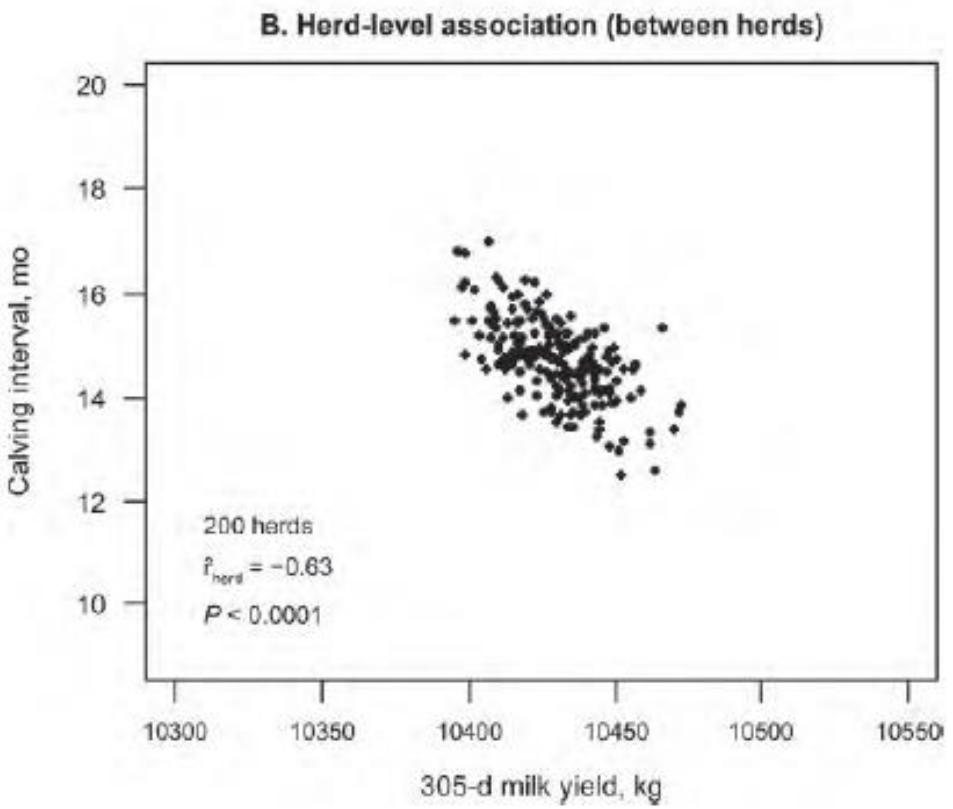
More precisely analyzed…..

Comparison within herds
～ 3 herds･200 cows each



Positive correlations within herds

Comparison between herds
～ 200 herds



Negative correlation between herds

Physiology and management

- Results from experimental herds ⇒ Physiology
  - Limited management effects ≠ Field condition
  - To detect the changes in reproductive physiology of cattle
  - Very limited information on the management factors

- Results from field data ⇒ Management
  - One herd: Case reports
  - Multi-herds: Epidemiological study ⇒ Management factors
  - Very limited information on the physiological factors

- Evaluation of the results from the different sources ⇒ Resolution
  - Conflicting results: Critical evaluation for the background of data

Physiological changes in dairy cattle

- Production level
  - High-Producing ⇒ Steroid (E_2, P_4) metabolism↑
  - Estrous intensity↓, Double ovulation↑, Pregnancy loss↑
- Energy balance (EB)
  - Insufficient feed intake to support high production level
    ⇒ Negative EB
- Delayed first ovulation and estrus postpartum
  - Effects of negative EB
  - Earlier ovulation ⇒ Earlier estrus ⇒ Earlier conception ?
- Uterine environment and involution
  - High-protein diet affects uterine environment ?（relation to AI timing）
  - Progesterone exposure and uterine involution

Negative energy balance impairs fertility ?

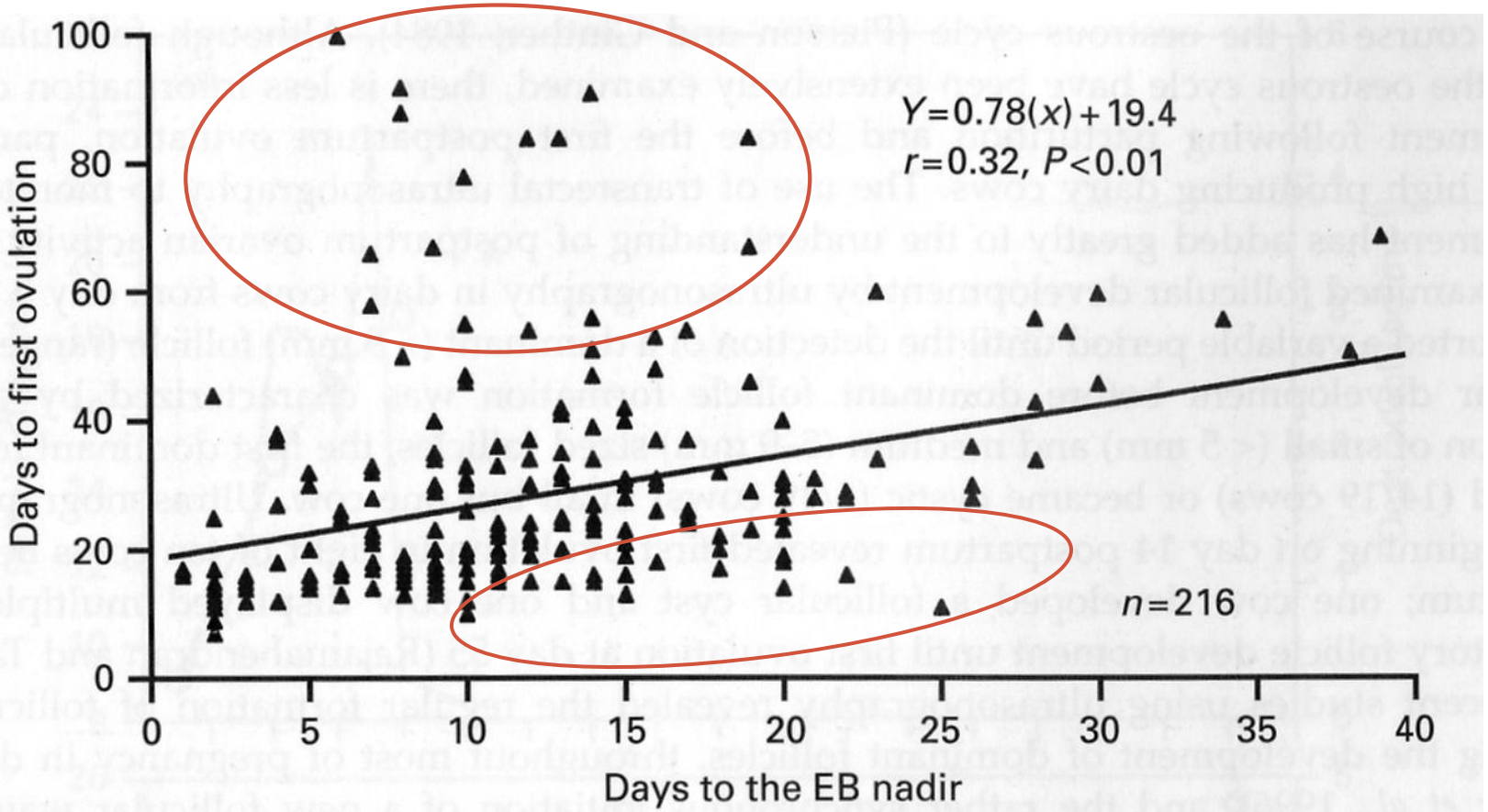


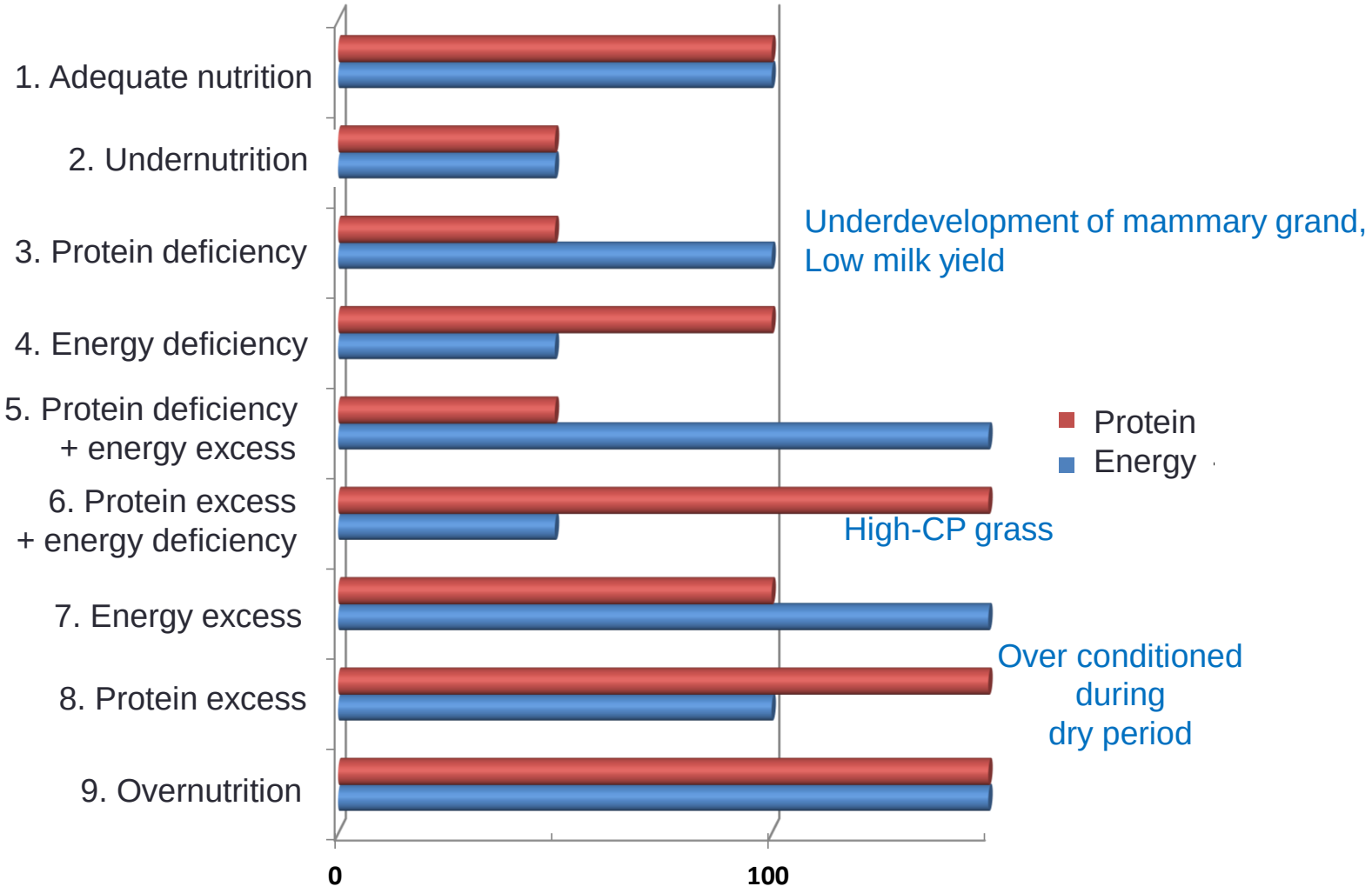
Fig. 2. Linear regression of the number of days to the first postpartum ovulation on the number of days to the energy balance (EB) nadir in dairy cows. Data include observations from five separate studies: Canfield *et al.* (1990); Canfield and Butler (1990, 1991); Beam and Butler (1997, 1998).

Beam & Butler (1999)

Fertility is dominated by EB only?

- Threshold level of negative EB affecting fertility?
  - Herd level EB is a good index but not in individual level
- High-protein diet affects fertility
  - Undesirable uterine environment by lowered pH
  - Low fertilizability of oocytes, low developmental competence
- Pasture grass at spring flush
  - A typical diet with high-protein and low-energy
- Milk and blood urea nitrogen (UN) as indices
  - Abnormal MUN always affect fertility?

Relationship between protein and energy nutrition



Cows can tolerate temporal high-protein diet

- Energy deficiency potentiate the negative effects of high-protein nutrition
  - Energy need for protein metabolism

  (Energy intake impacts on protein metabolism)
  - Unutilized nitrogen ⇒ NH_3 or Urea ⇒ Urine

    （Economic loss, Environmental load）
  - Excessive high-protein induces temporal elevation of milk yield and thereafter decline of BCS

- Dietary changes (CP) around artificial insemination
  - Laven et al. (2007, Vet Rec）
  - Changes before 10 d or earlier does not affect conception rate
  - Drastic changes at the onset of grazing at spring

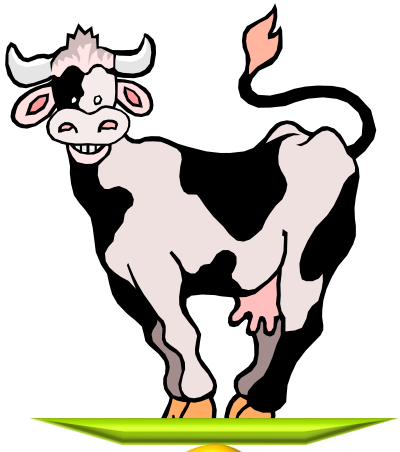
Lactation as a part of reproductive activity

- Mating(estrus) - Pregnancy - **Lactation**（suckle）
  = Reproductive activity ⇔ Individual growth/maintenance
  （Differed from beef cattle）
- Unbalanced nutritional distribution
  = Priority to lactation using her body reserve (fat, protein)

- Heritability: high in lactation traits, but low in fertility traits
  = Milk production ability resists changes in nutritional management
  （Larger affects on fertility than on milk production）

Individual maintenance > Fetal growth > Lactation > Conception

A few decades later….?



Under sophisticated management condition, high production with desirable fertility

More increase in milk yield
Expanding herd size

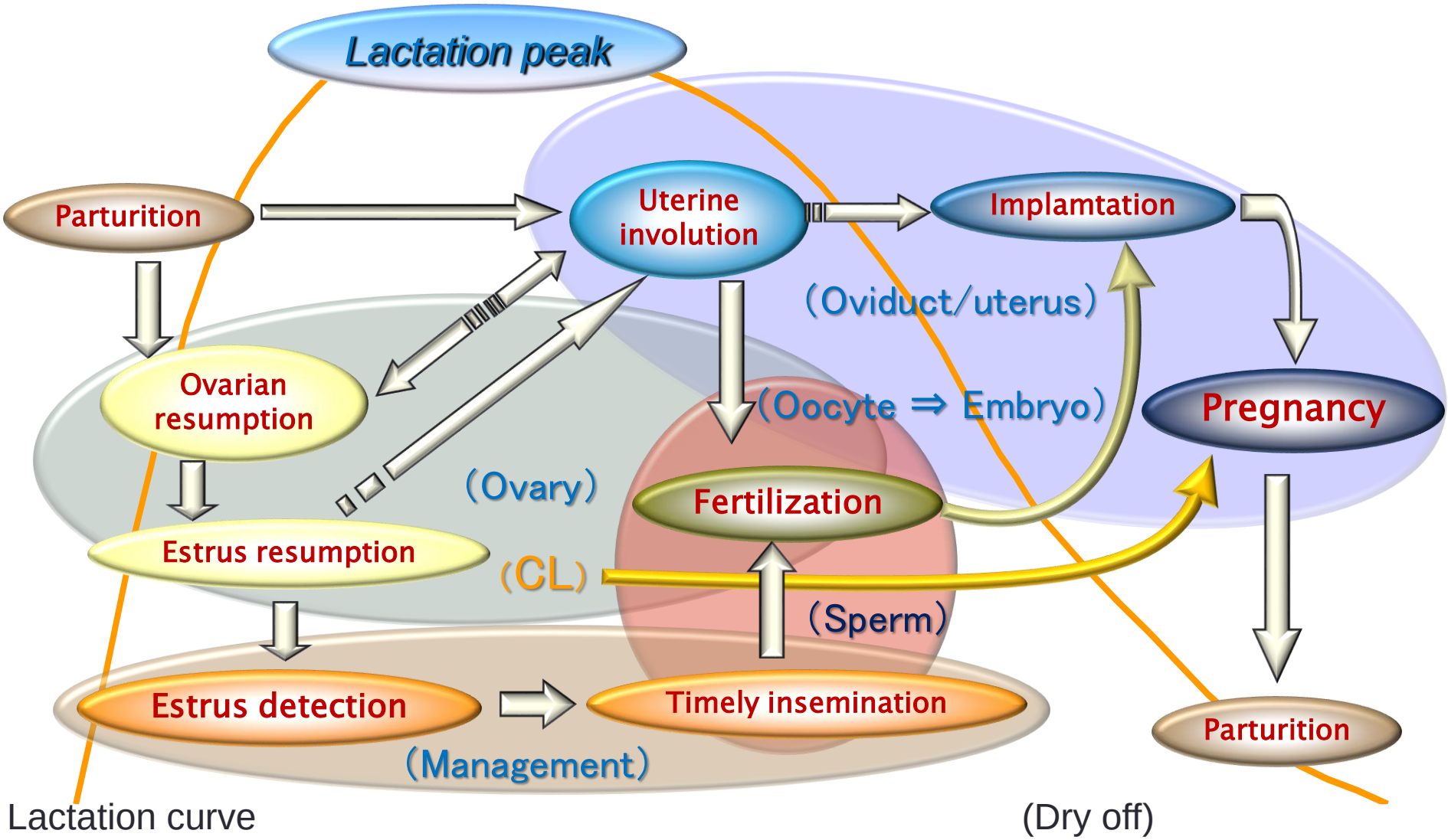
What will be a safety net?

More herds fall into critical status

2. RESUMPTION OF OVARIAN AND ESTROUS ACTIVITIES

As predictors for breeding success

From parturition to parturition



Hokkaido Agricultural Research Center, NARO

Holstein, 100 heifer/cow
30～40 lactating

Data from a experimental herd

- National Agricultural Research Organization (NARO)
  - Hokkaido Agricultural Research Center (HARC)
- Postpartum 50 cows
  - Ultrasound examination
  - Estrous detection
  - Artificial insemination
  - Pregnancy diagnosis
  - Milking records

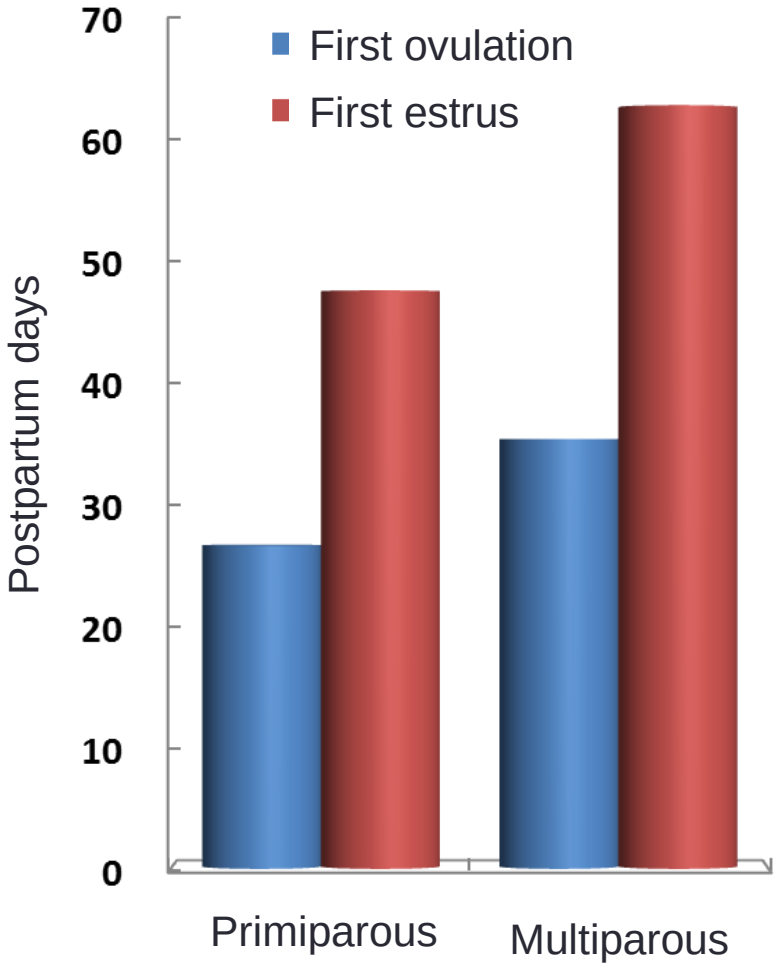
Summary

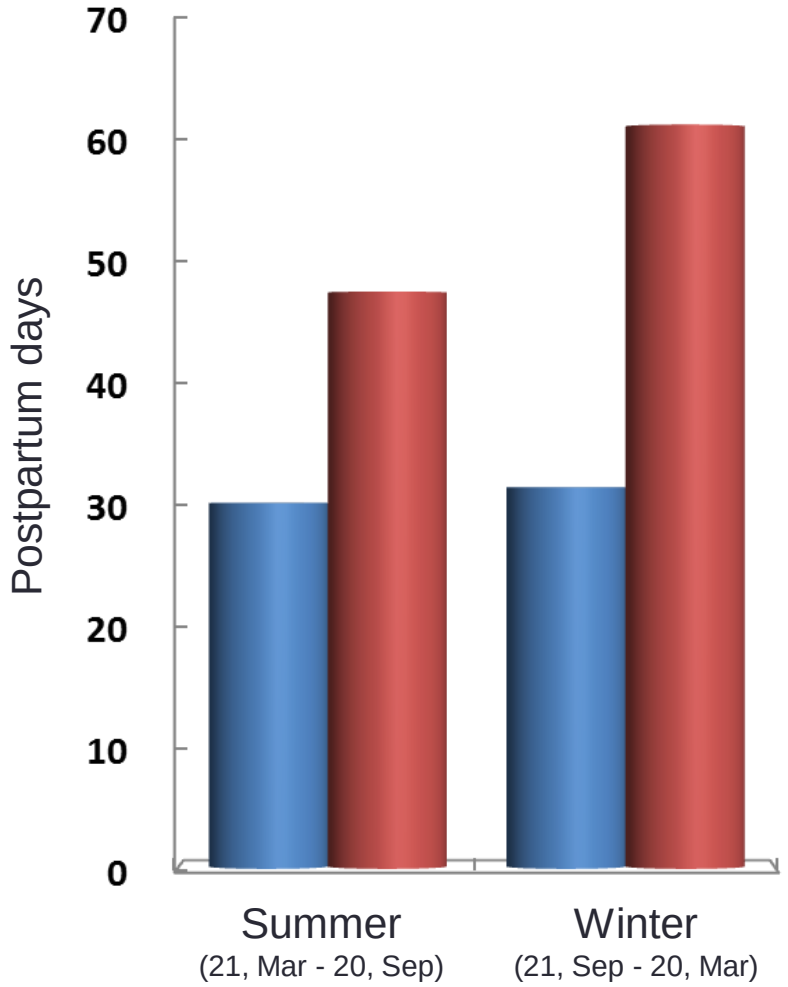
J Dairy Sci (2004)

Items	Mean	Min.	Max.
Lactation number	2.18	1	7
305-day yield, kg	9,265	5,847	13,718
Primiparous, 26 head	7,932	6,348	10,325
Multiparous, 24 head	10,708	5,847	13,718
BCS at calving	3. 14	2. 14	3. 77
BCS loss postpartum	0. 47	0. 13	1. 28
Interval to postpartum first ovulation, d	31	10	79
No. of anestrous ovulations	1. 36	0	3
Interval to postpartum first estrus, d	55	21	107
Interval to postpartum first insemination, d	72	45	129
No. of inseminations per pregnancy, 45 head	1. 62	1	4
Days open, 45 head	90	45	168
Adjusted days open*	96	45	168

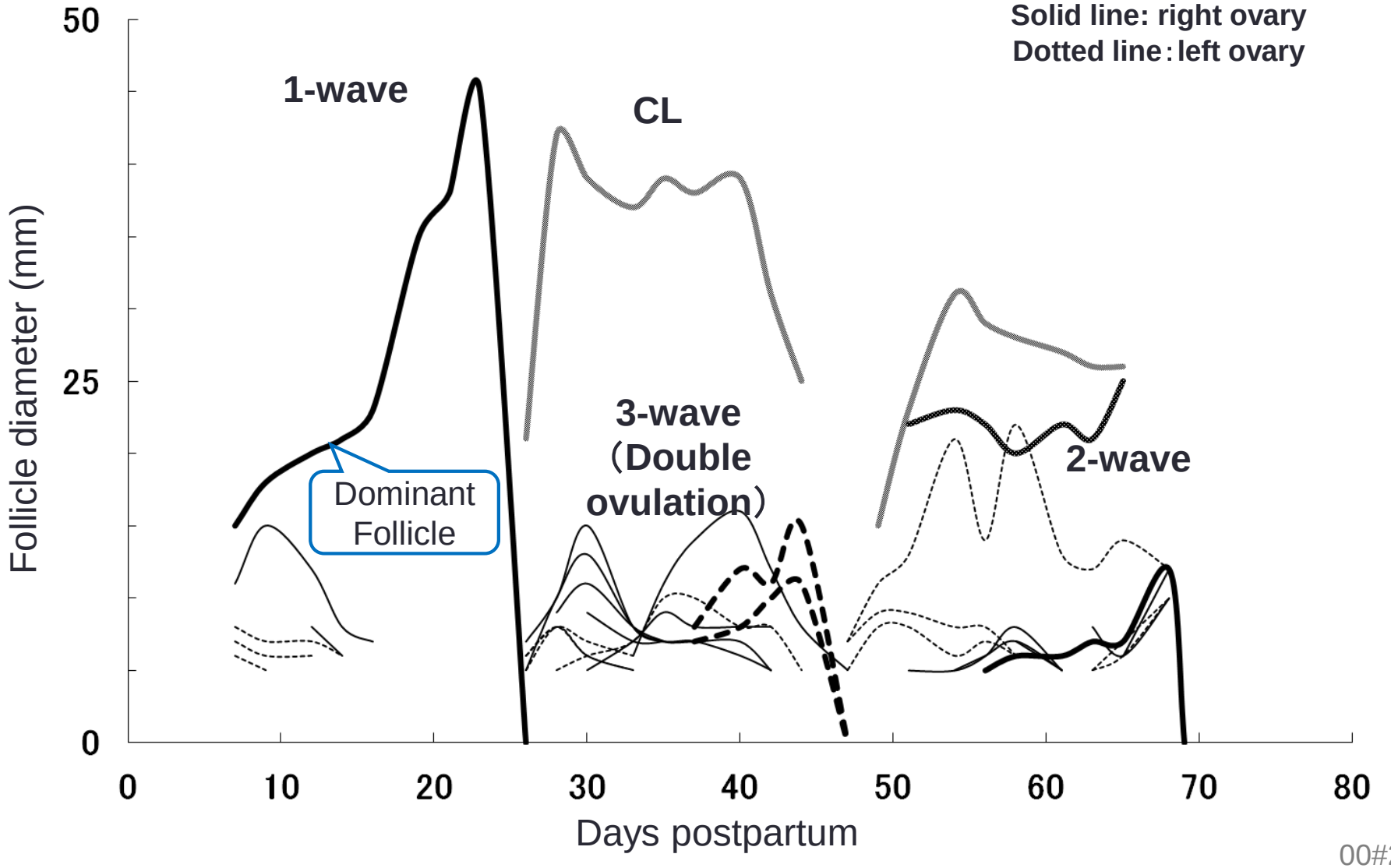
*Cows without a positive pregnancy diagnosis by 180 days in milk were assigned a days open value equal to 21 days after their last unsuccessful service

Effects of parity and season on the resumption of ovarian and estrous activities

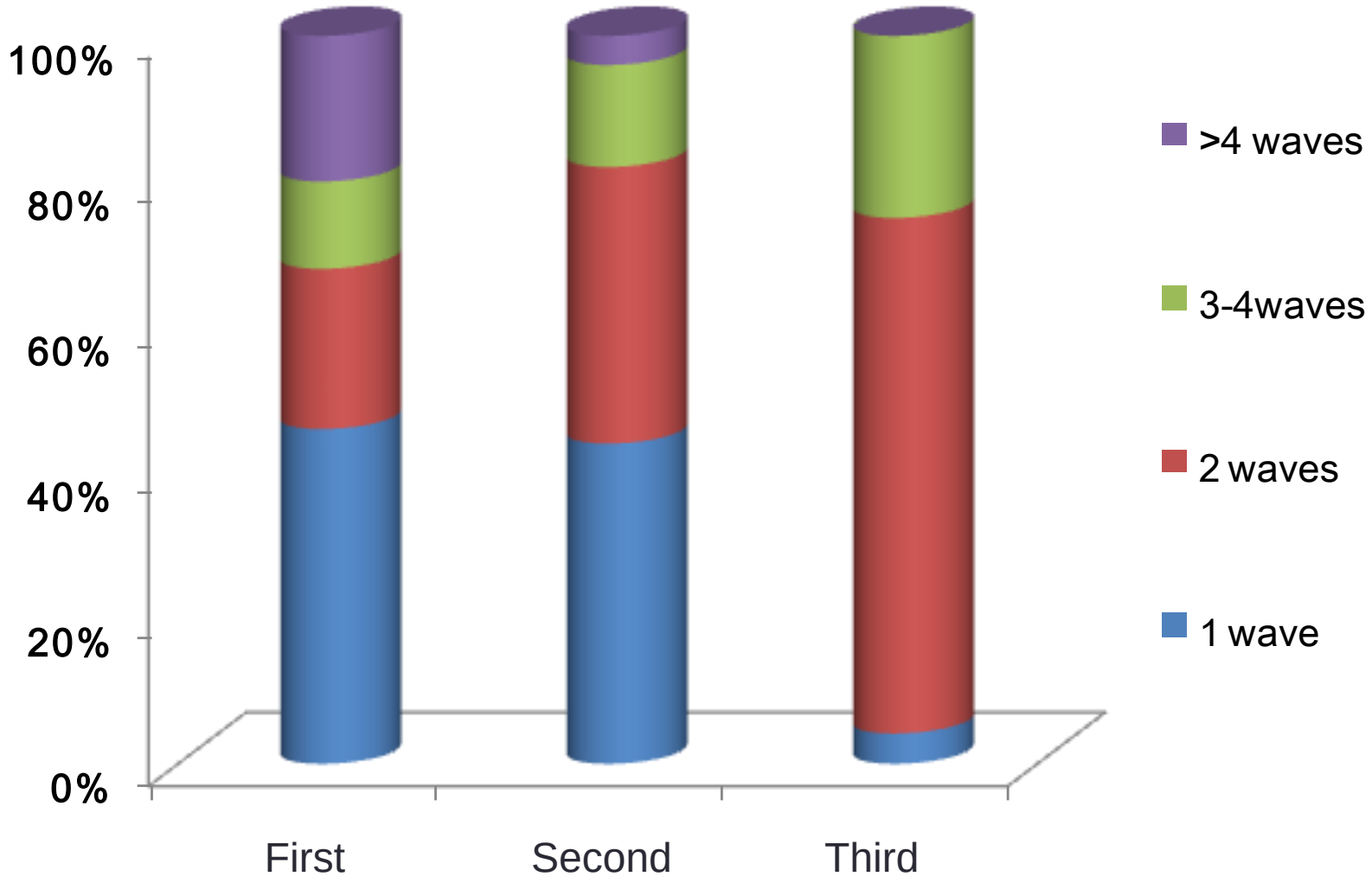




Follicular wave – a sample



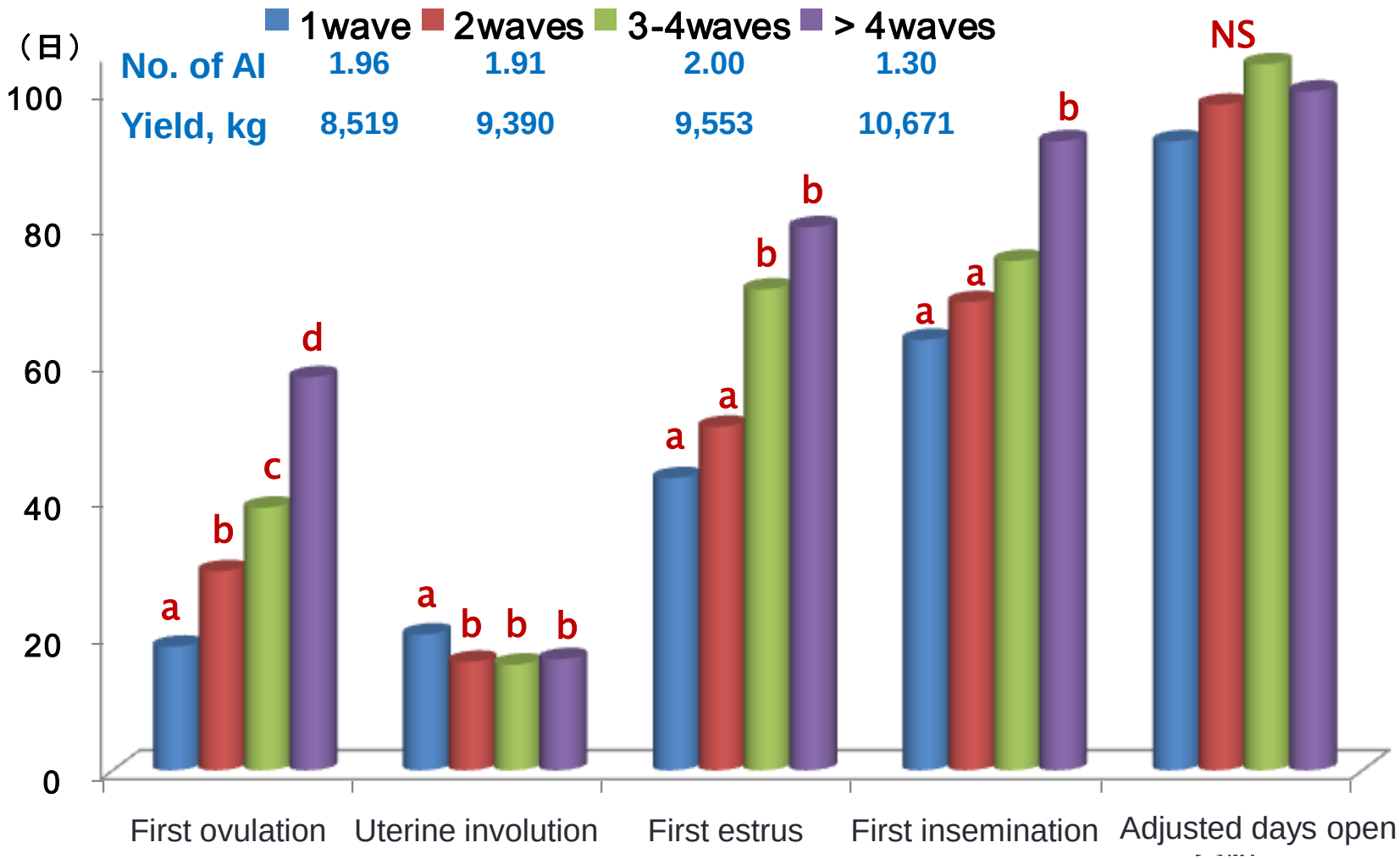
Early postpartum ovulations



J Dairy Sci (2004)

Normal distribution at the third

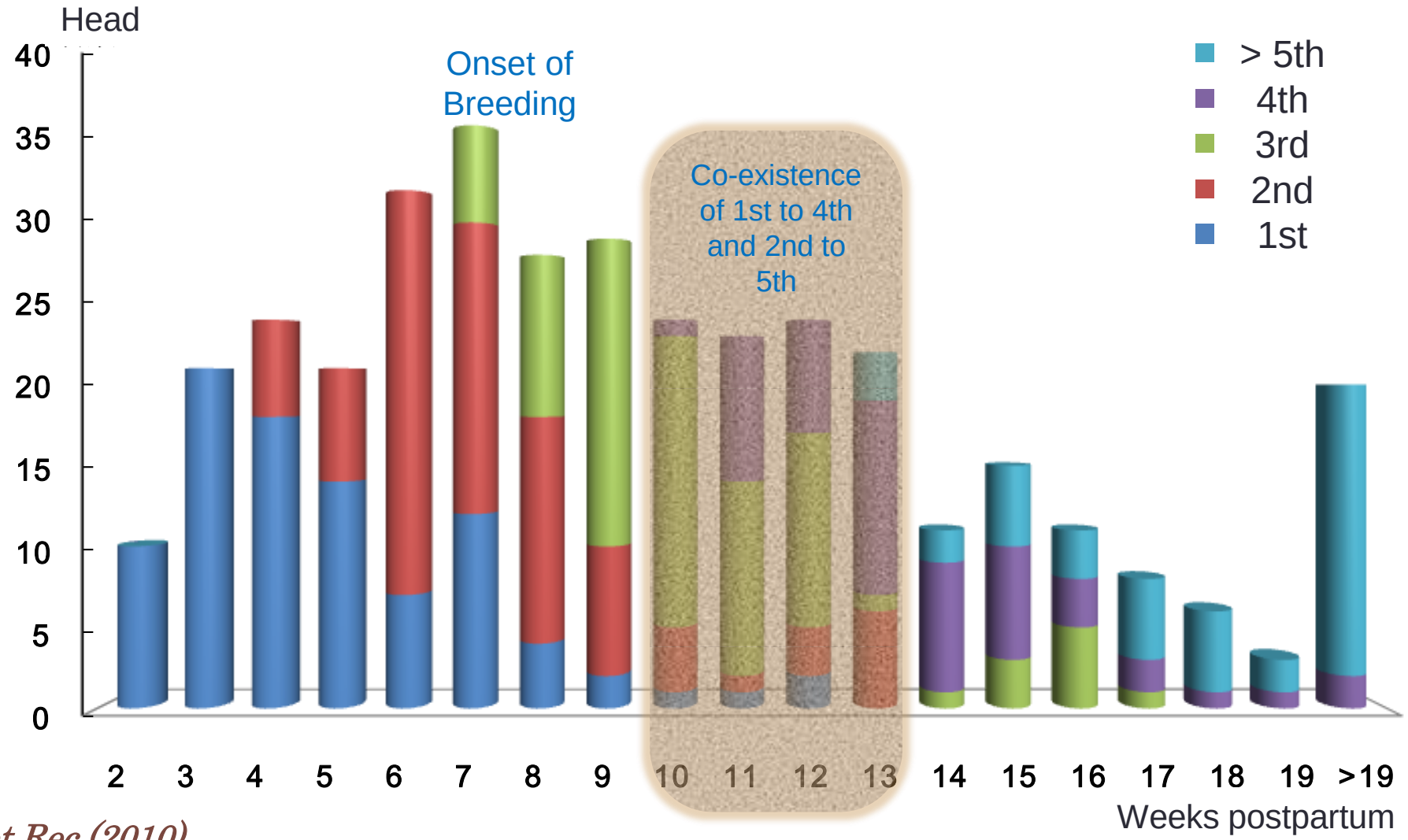
Fertility among the ovulation groups



J Dairy Sci (2004)

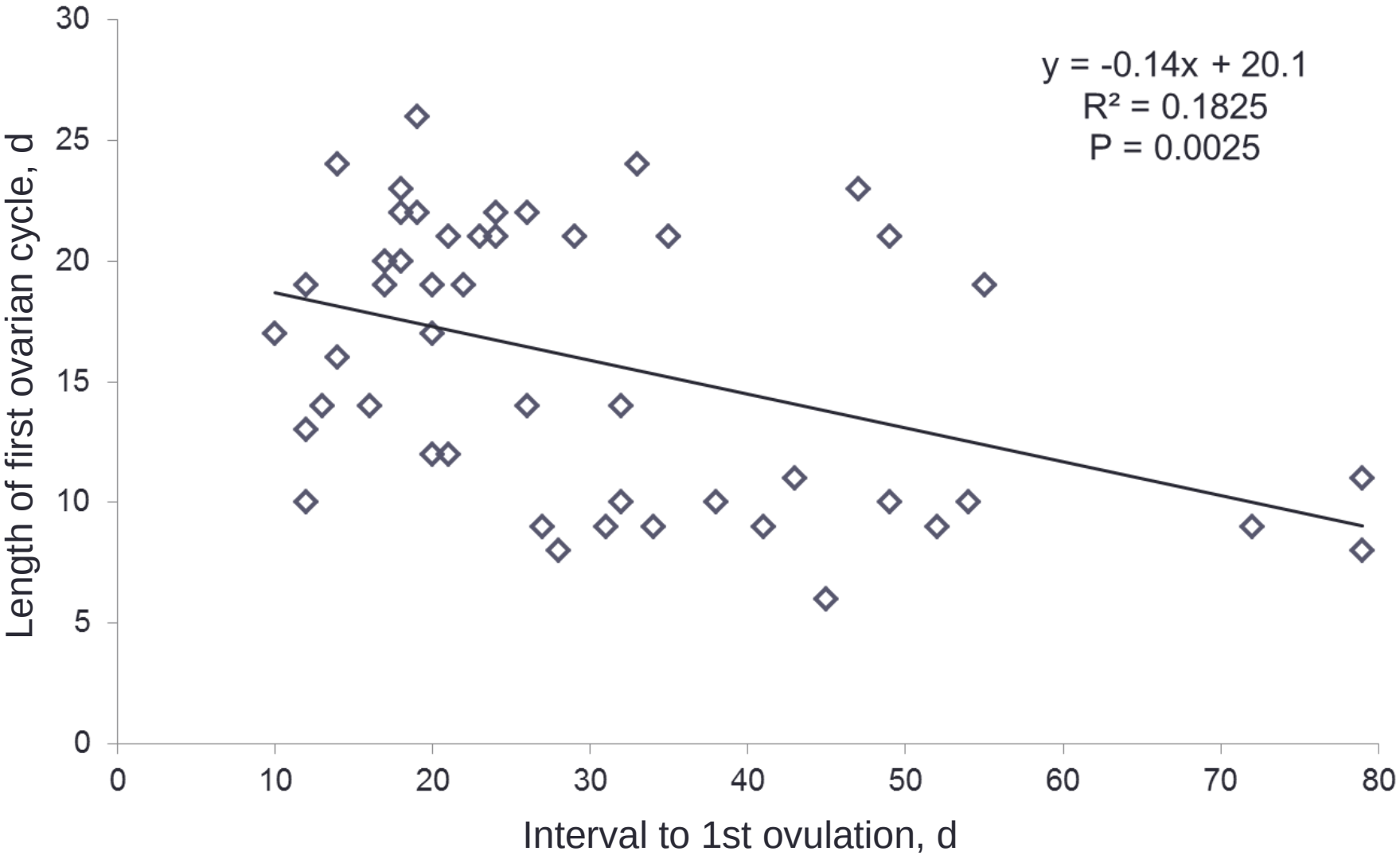
Distribution of ovulation timing

（69 head, 92 parturitions, 368 ovulations）

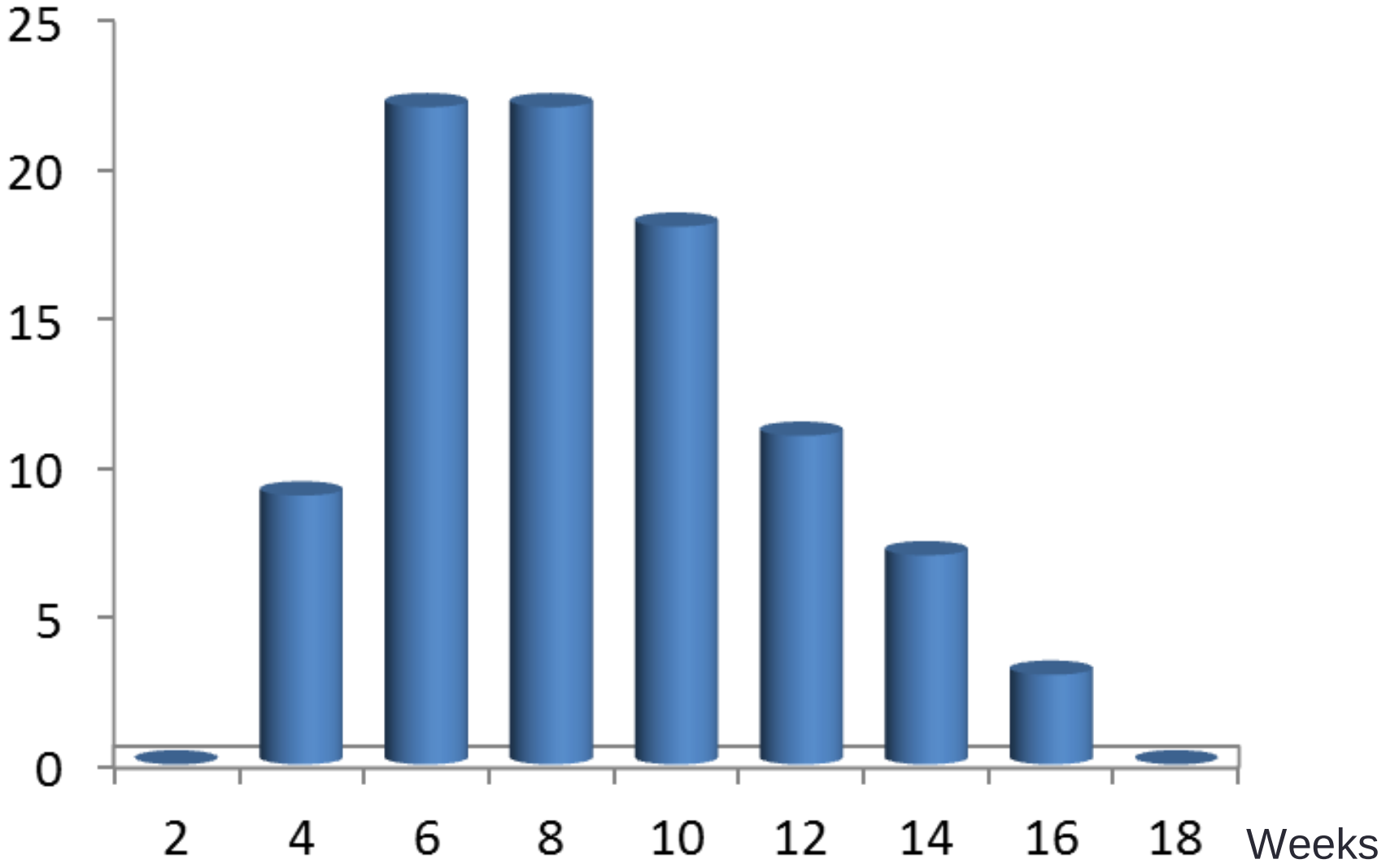


Vet Rec (2010)

Late 1st ovulation induces short cycle

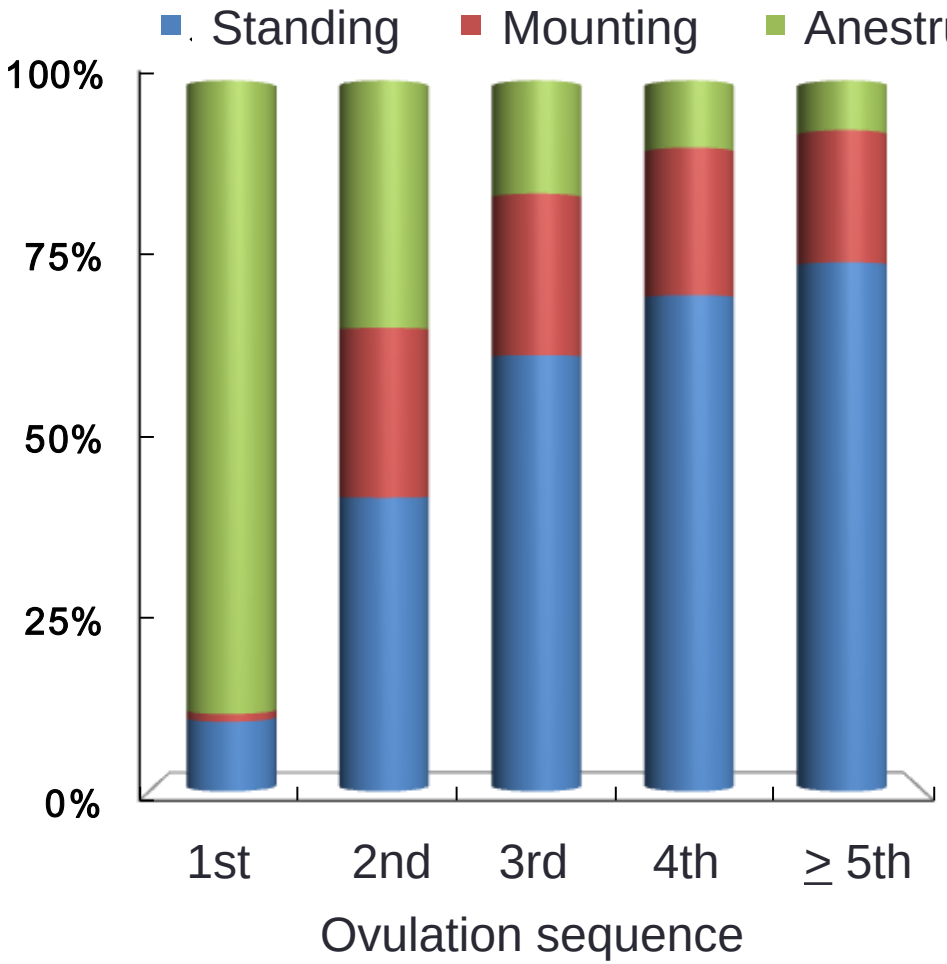


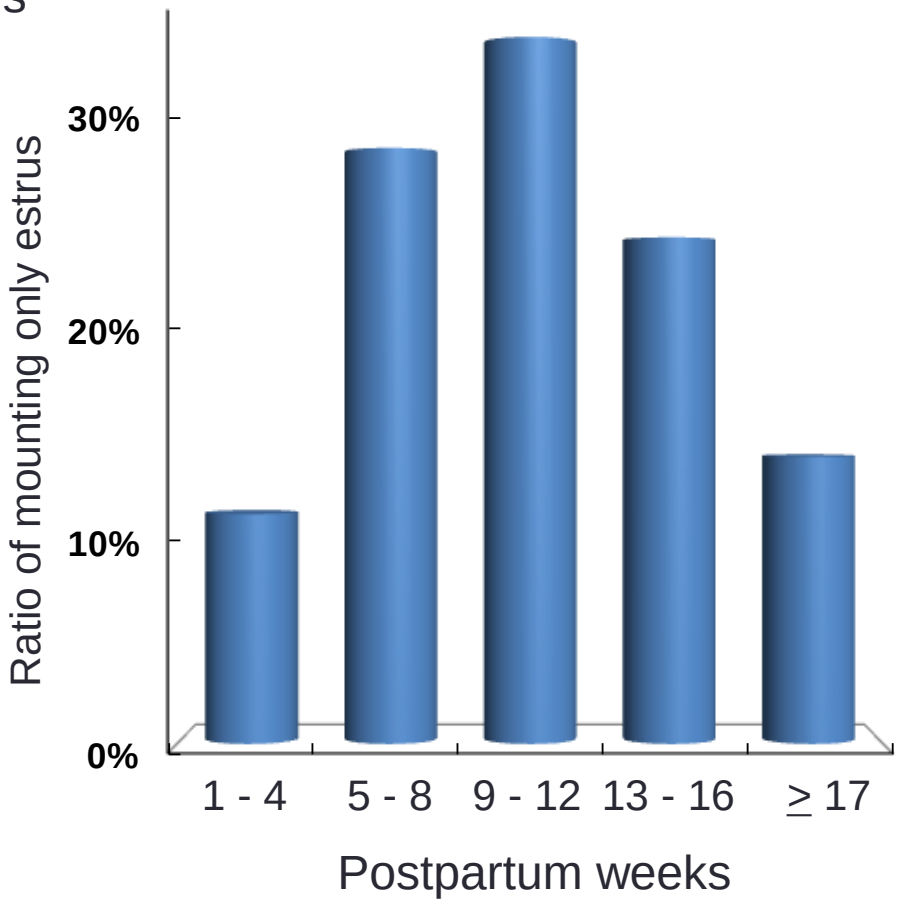
Distribution of postpartum first estrus



Intensity of estrous behavior

Anestrous ovulation and mounting only estrus

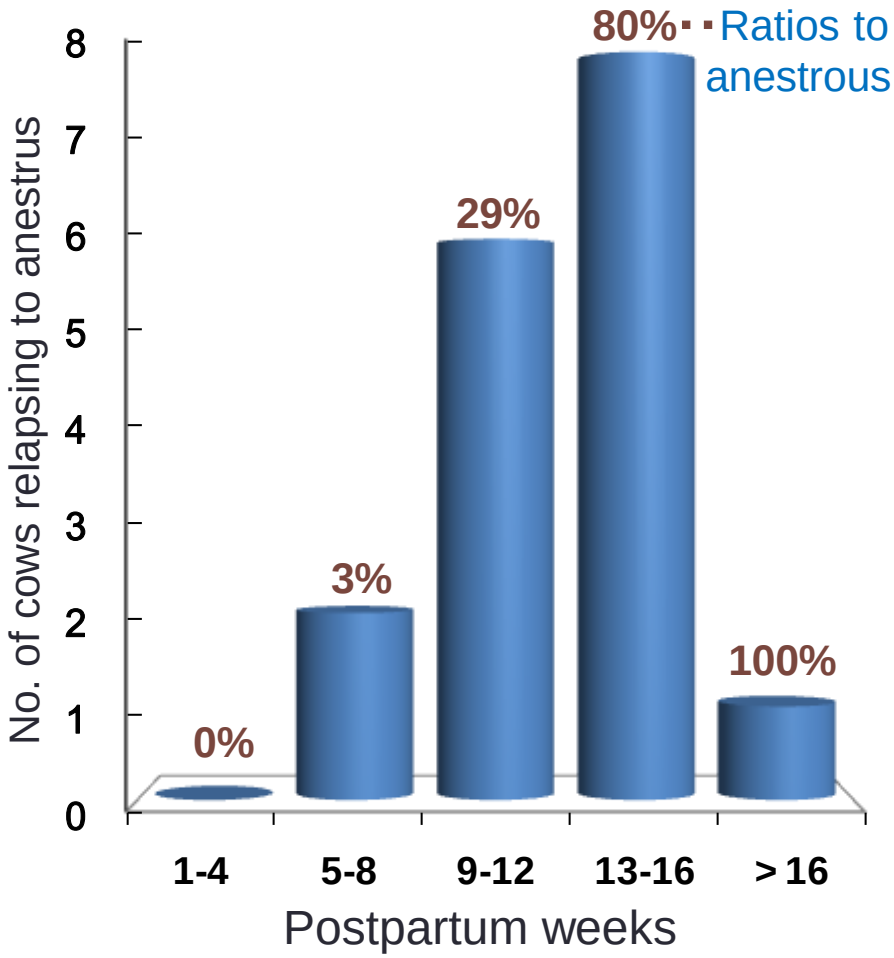




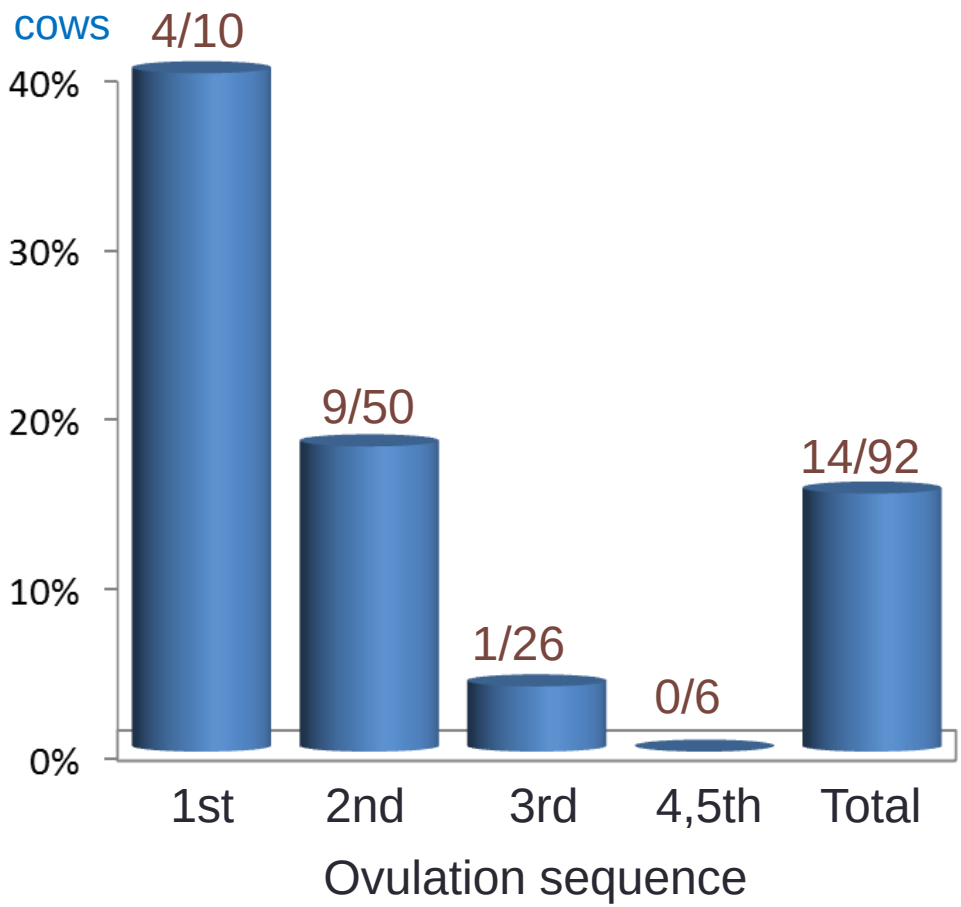
Vet Rec (2010)

Relapse back into anestrus

Mean anestrous period; 48.1 d

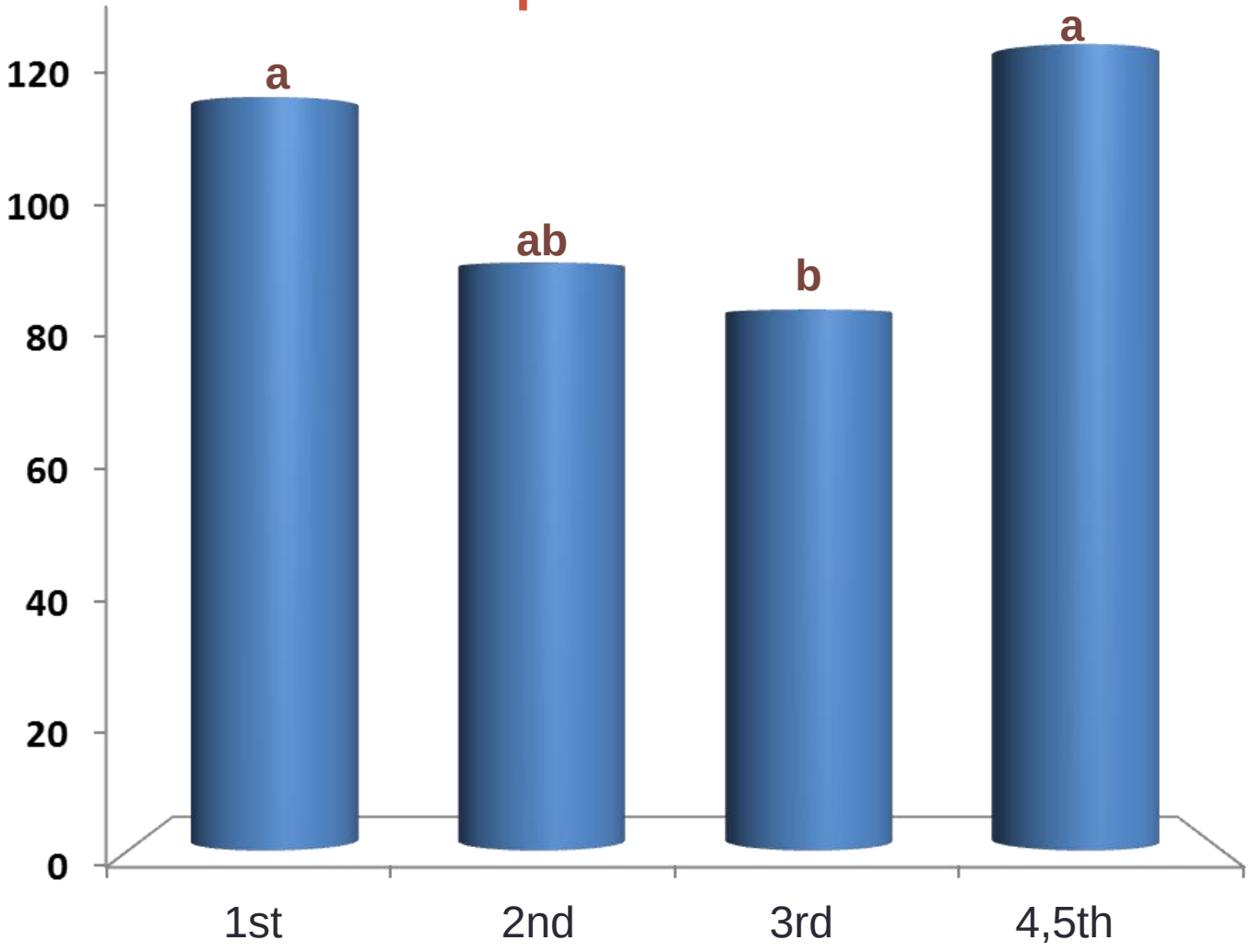


Occurrence of relapsing



Vet Rec (2010)

Days open of cows at different timing of estrous resumption

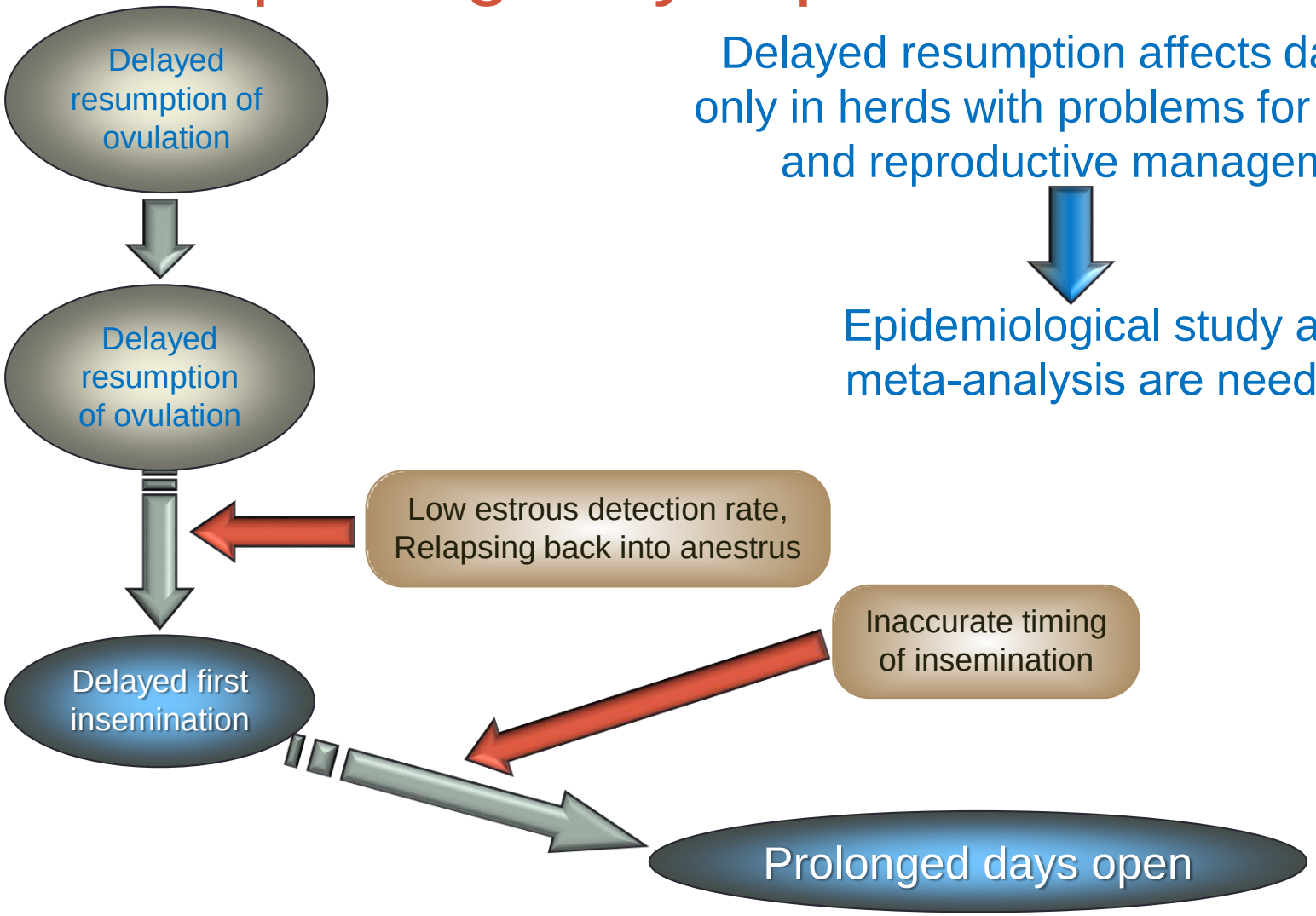


Vet Rec (2010)

Ovulation and estrus as an insemination timing predictor

- Ovarian cycle is normalized within postpartum 3rd ovulation
- Intervals to resumption of ovarian activity did not affect days open
- First to 5th ovulations coexists between 10 to 13 weeks postpartum
- Mounting without standing estrus increased at the onset of breeding
- Relapsing back into anestrus
- First estrus at 2nd or 3rd ovulation might shorten the days open

Delayed resumption of ovulation and/or estrus prolongs days open?



Delayed resumption affects days open only in herds with problems for nutritional and reproductive management ?

Epidemiological study and meta-analysis are needed

Reconsider the best insemination timing

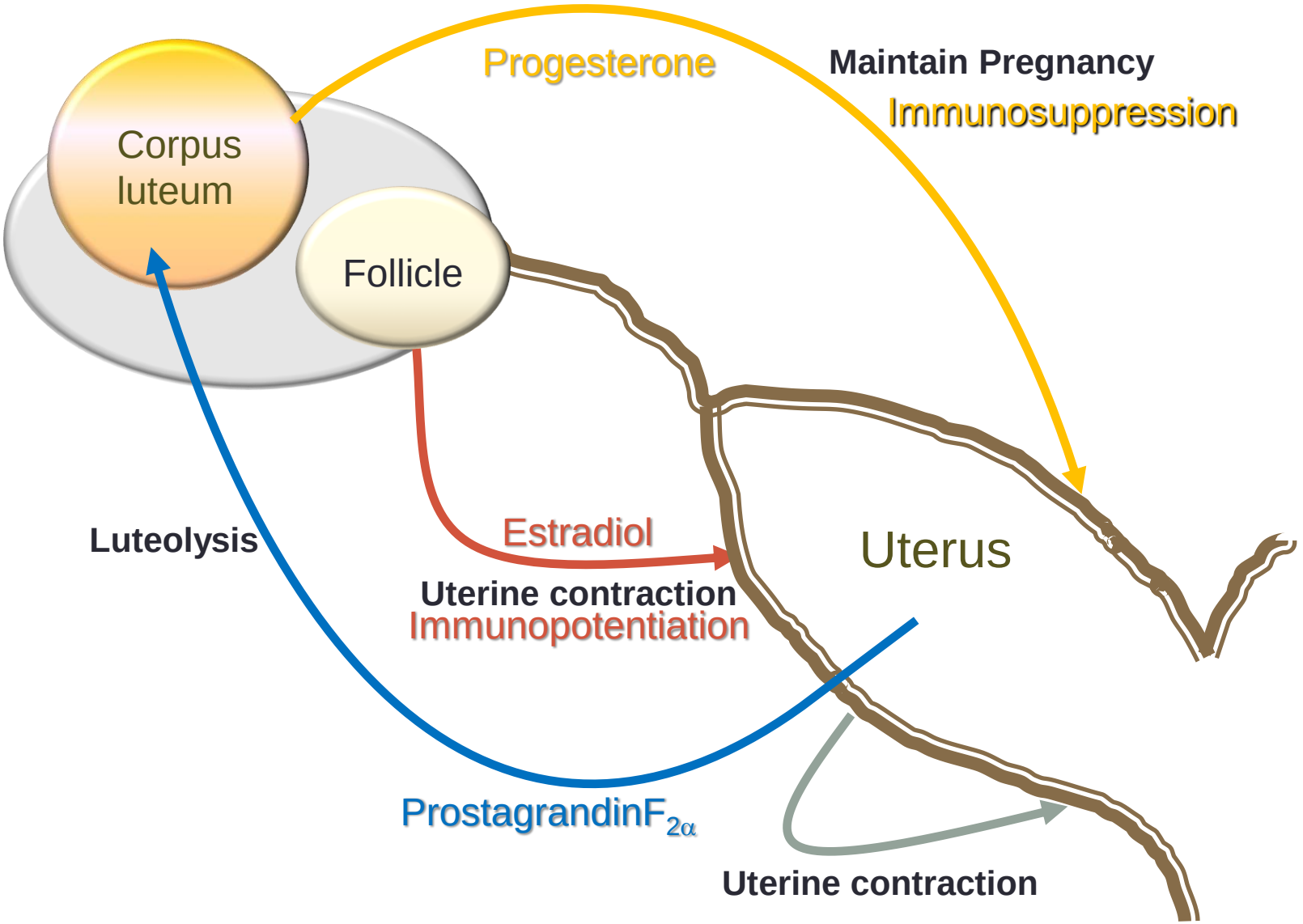
- Standing estrus as an indicator
  - Number/estrus↓; Duration/estrus↓
  - Early timing from the onset of estrus is recommended?
  - Number of cows in estrus: single vs. multiple
- Estrus symptoms other than standing as ovulation indicators
  - Mounting only (no partners?)
  - Increased activity（pedometer）
- Practical aspects
  - Larger deviation not fixed tendency?
  - Ovulation check after insemination ＝ Tendency of the herd

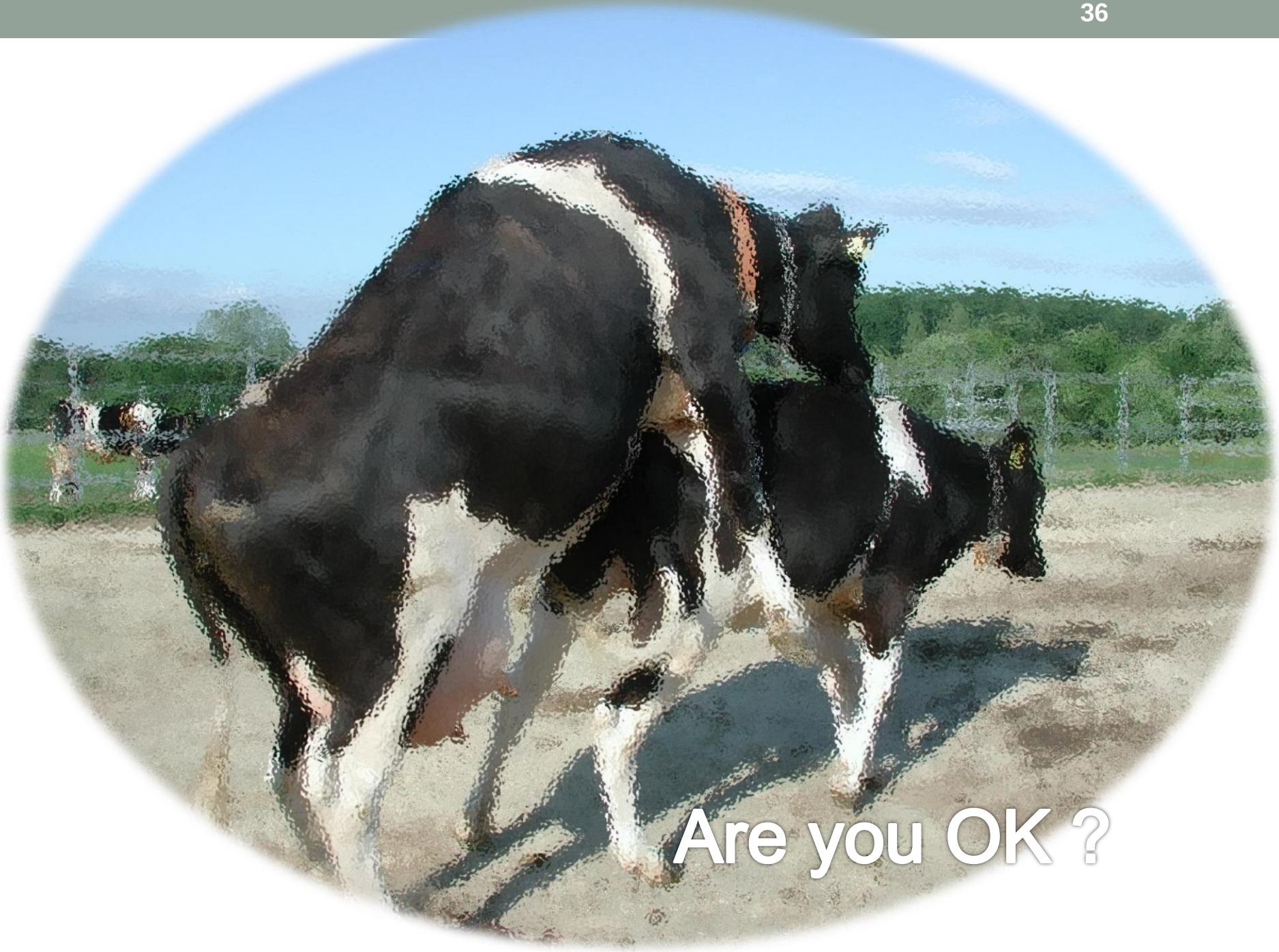
Uterine involution is indispensable for the establishment of pregnancy

- Difficult to diagnose subclinical endometritis
  - Infectious or non-infectious
  - Normal or abnormal? (discharge, postpartum period)

- Diagnostic methods for uterine abnormality is not as available as those for ovarian dysfunction
  - Rectal palpation, ultrasonography, and others
  - Relationships to ovarian function

Relationship between ovary and uterus



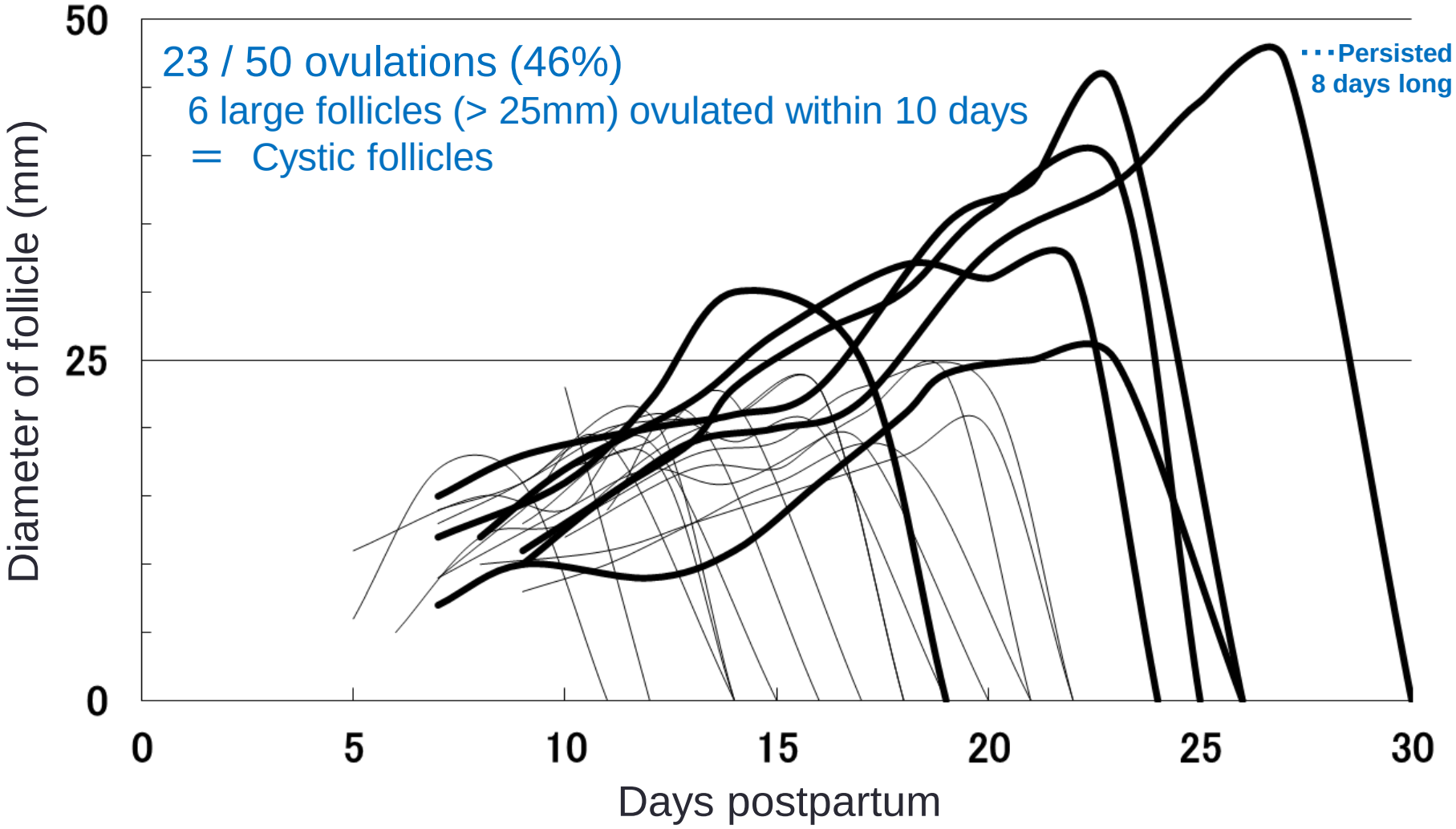

Are you OK ?

3. FATE OF FOLLICULAR CYSTS

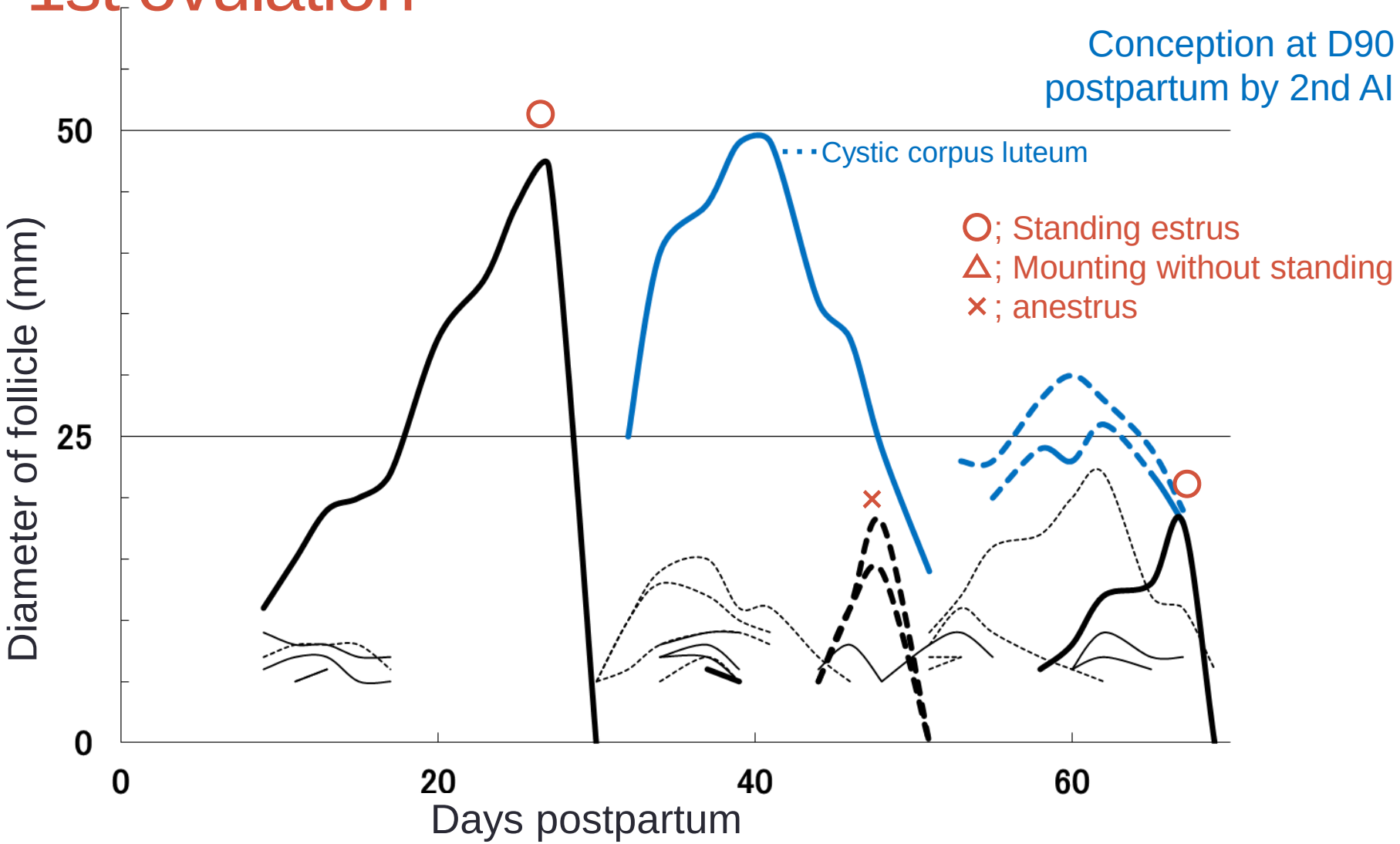
Spontaneous development during early postpartum period

Non-ovulatory repeated waves ＝ Ovarian quiescence ?

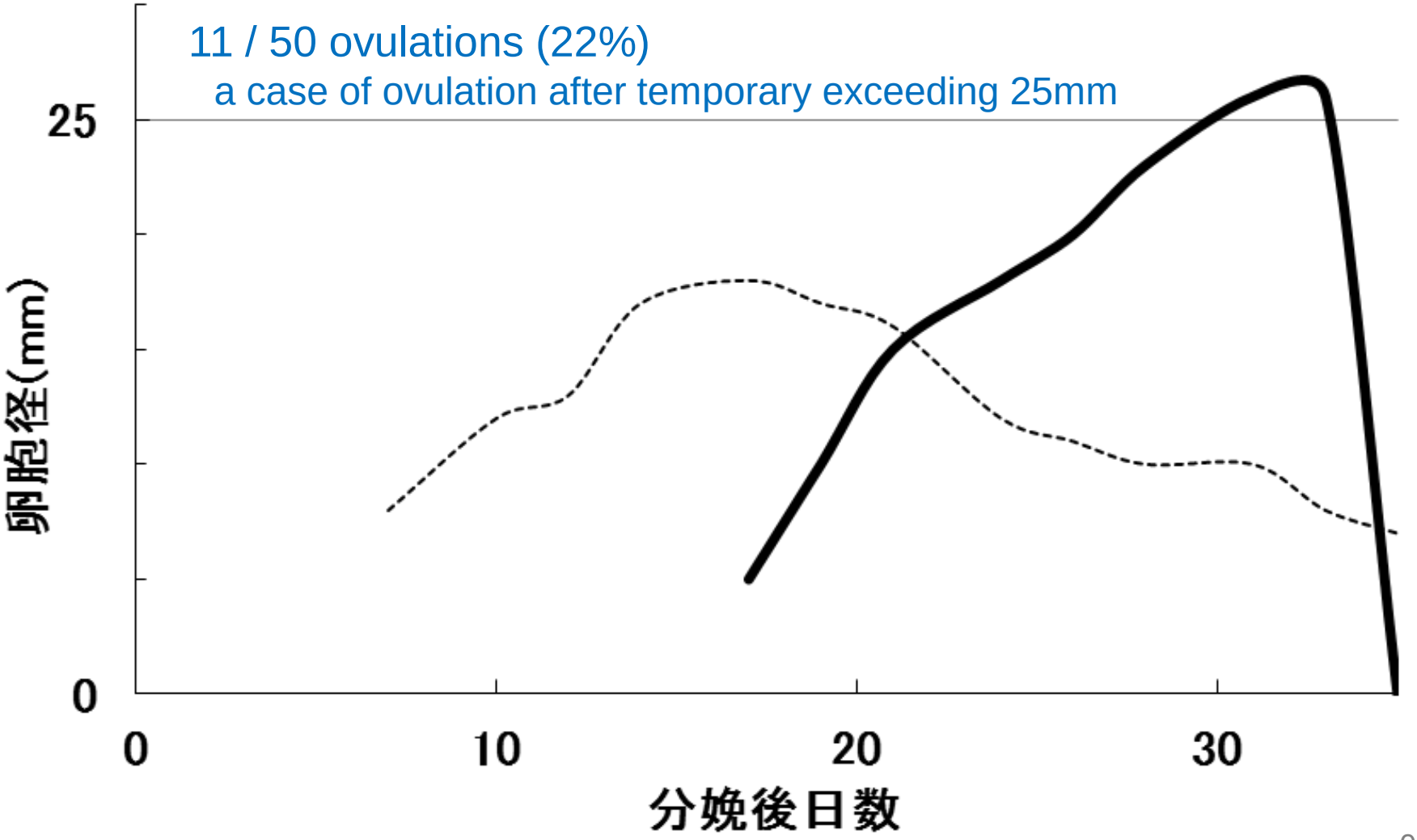
Ovulations after 1st follicular waves



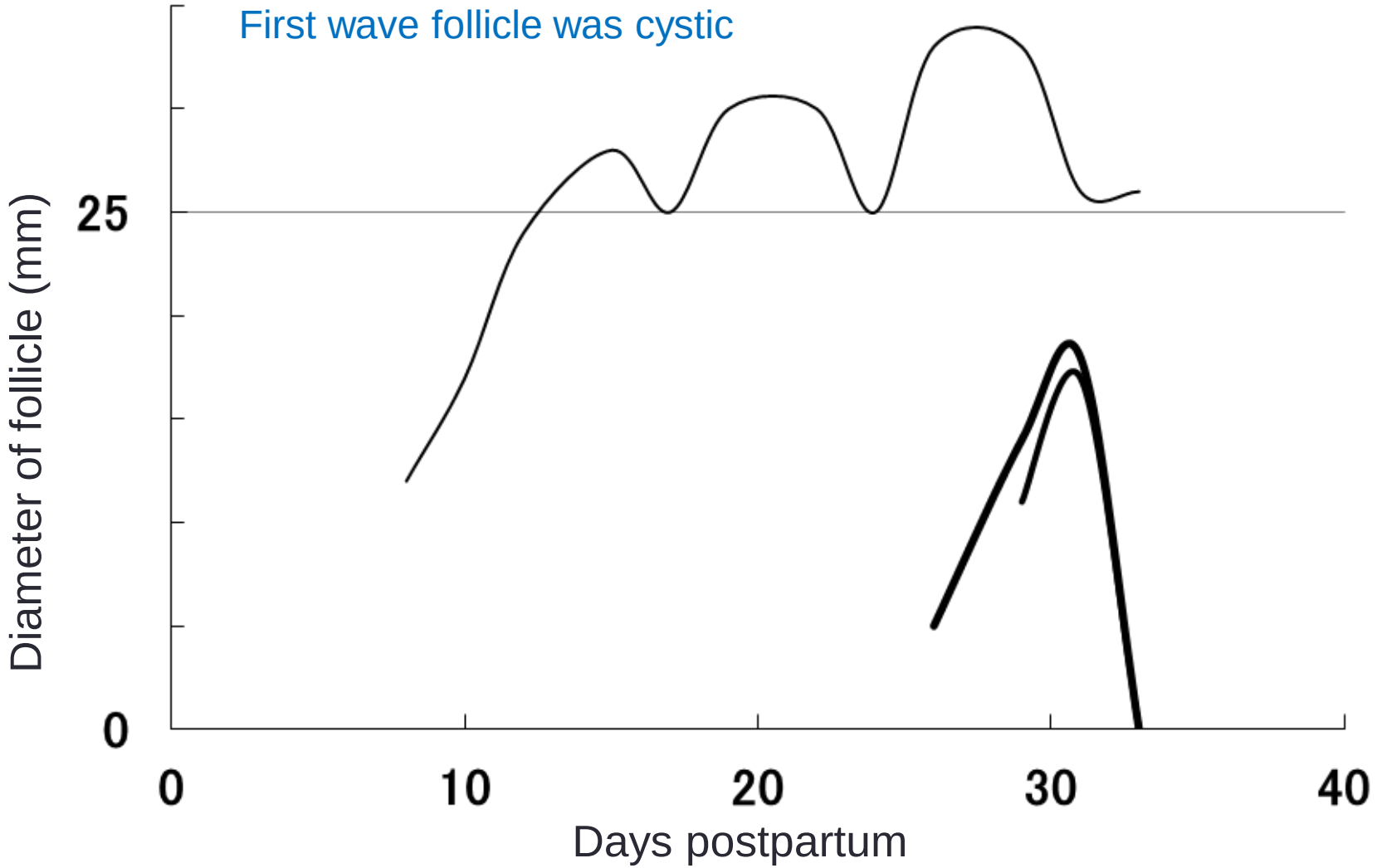
Fertility of a cow with cystic follicle before 1st ovulation



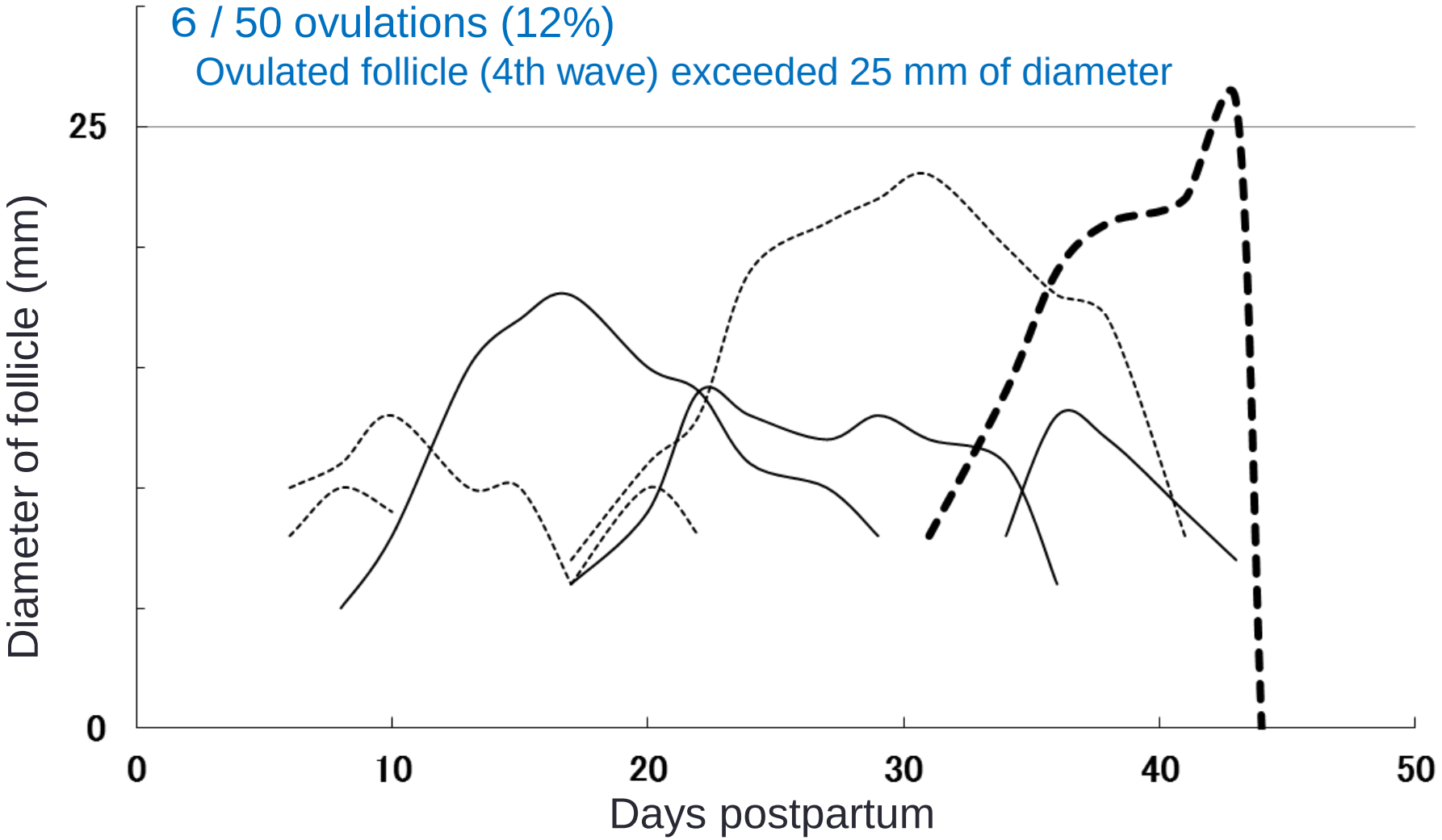
Ovulations after 2nd follicular waves



Ovulation at 2nd follicular waves



Ovulation at 3rd to 4th follicular waves



Other ten first ovulations

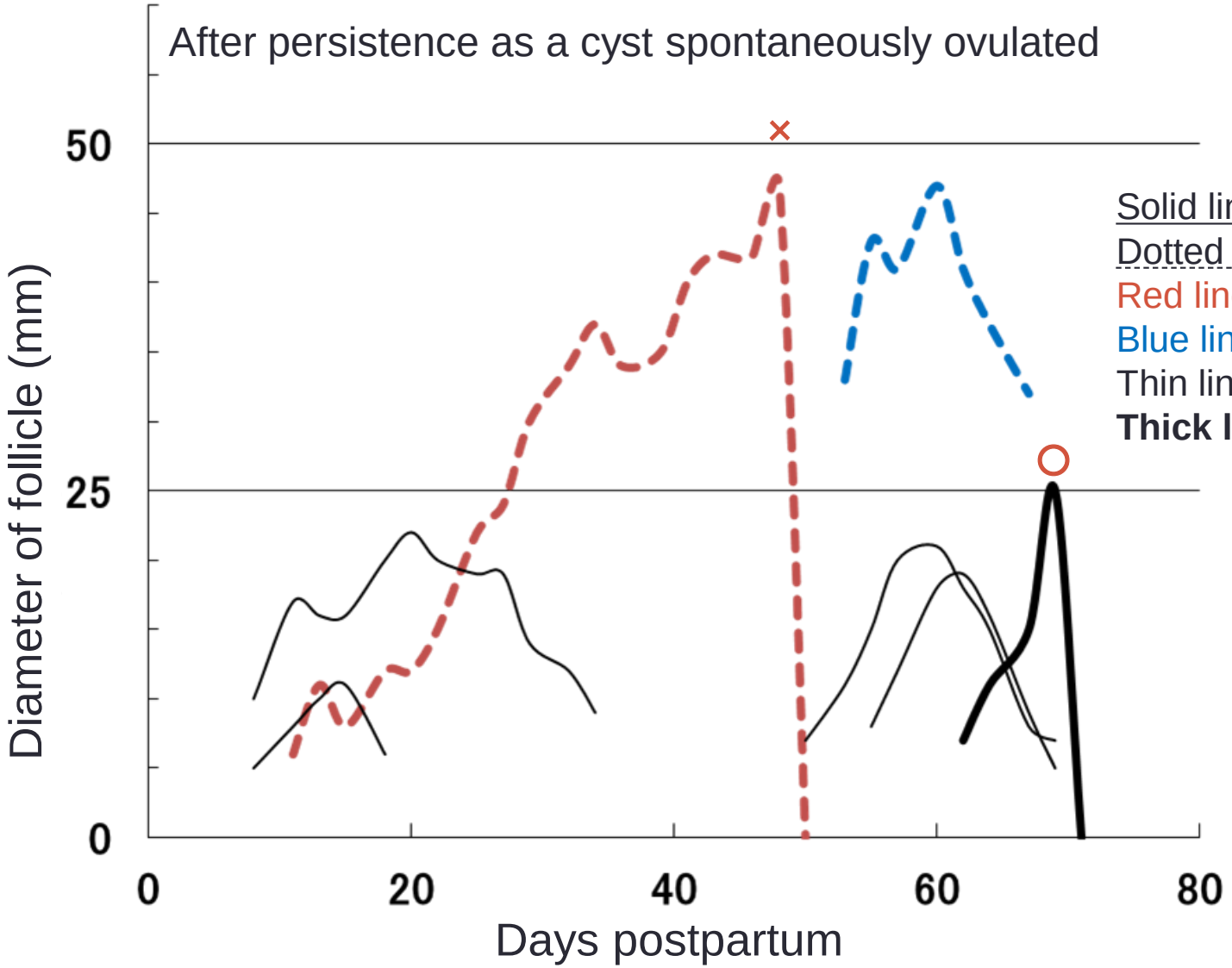
- 5 ovulations: Developing follicular cysts
  - 4 ovulations: Cysts developed from the first wave follicles
  - 1 ovulation: A cyst developed after the first ovulation

- 6 ovulations: Ovulated after more than 5 follicular waves (repeated follicular waves）
  - 4 ovulations: 5 to 7 waves
  - 2 ovulations: more than 8 waves?

Vet Rec (2006)

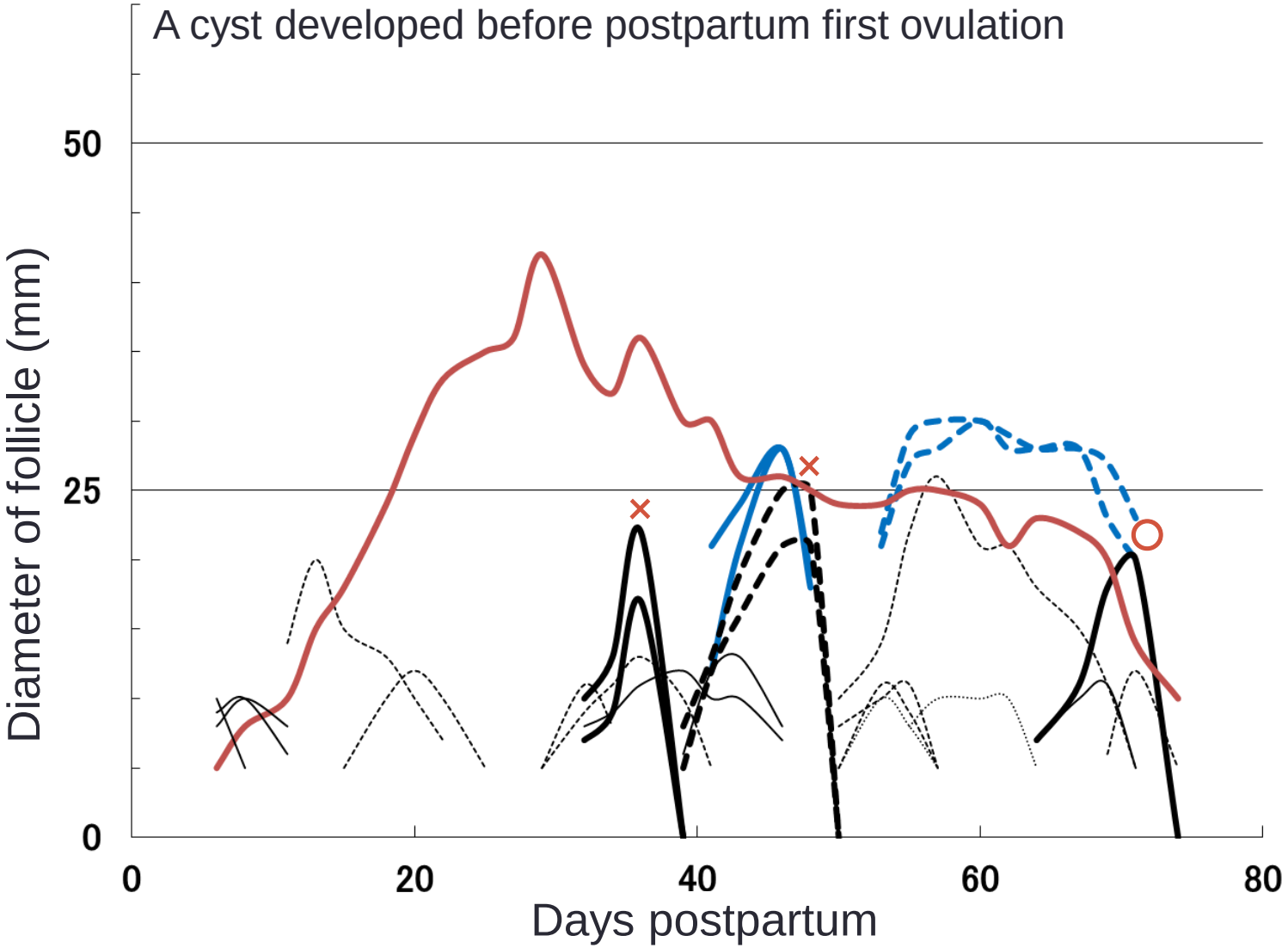
Follicular cyst - 1

Conception at D69 postpartum by the 1st AI



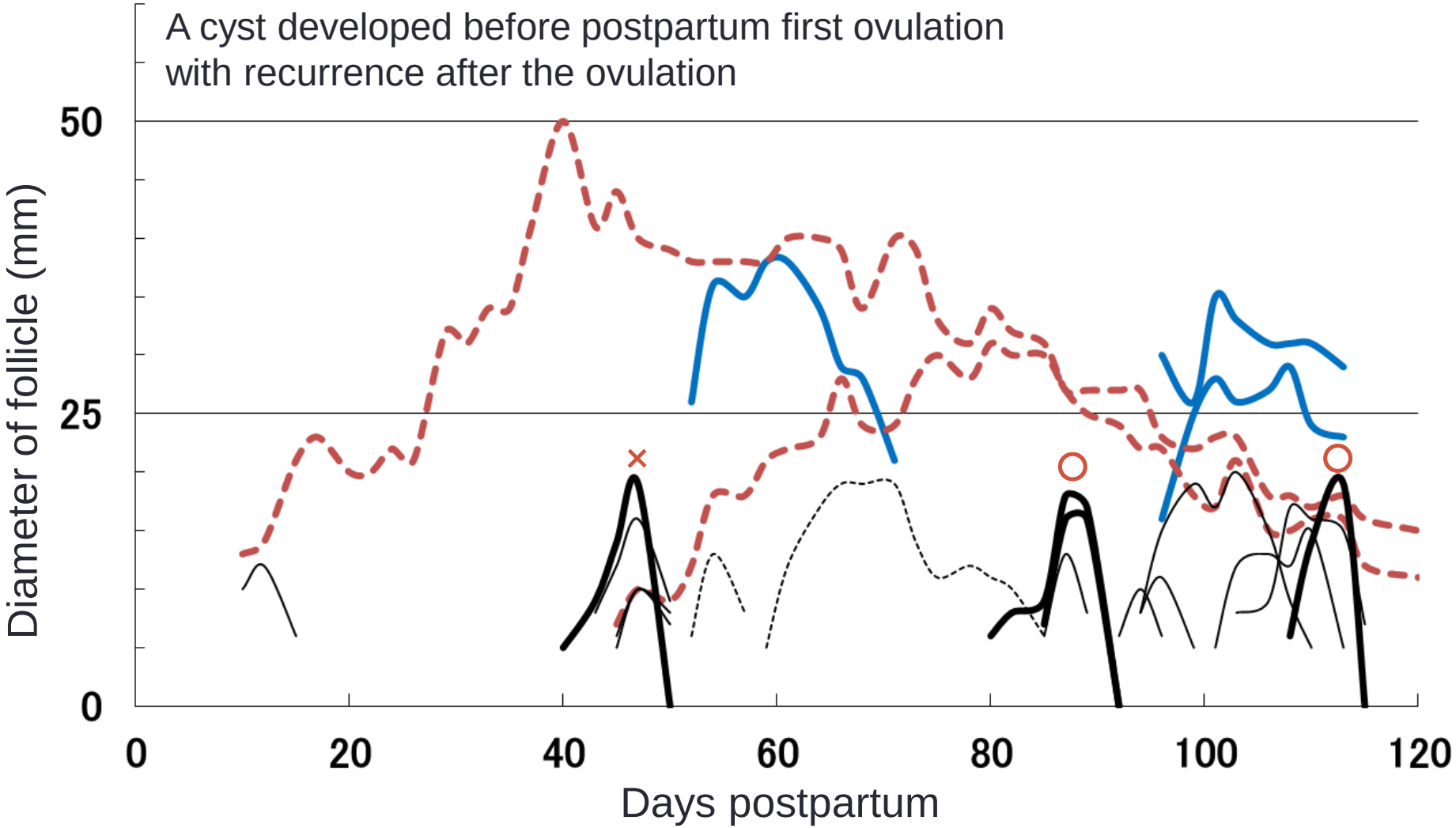
Follicular cyst - 2

Conception at D138
postpartum by the 3rd AI
(Embryonic death after the 2nd AI)



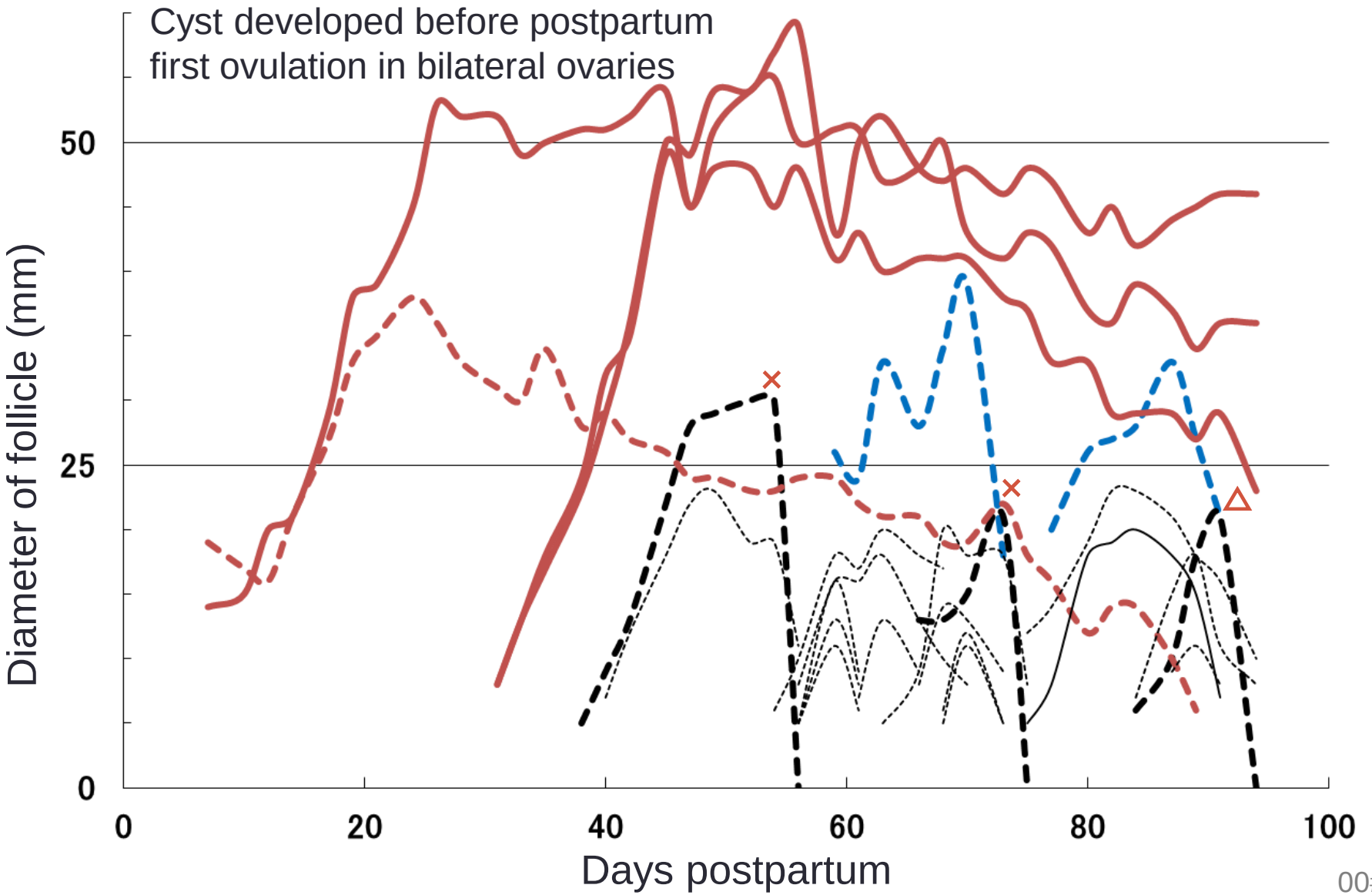
Follicular cyst - 3

Conception at D168
postpartum by the 2nd AI
(recurrence at D150)



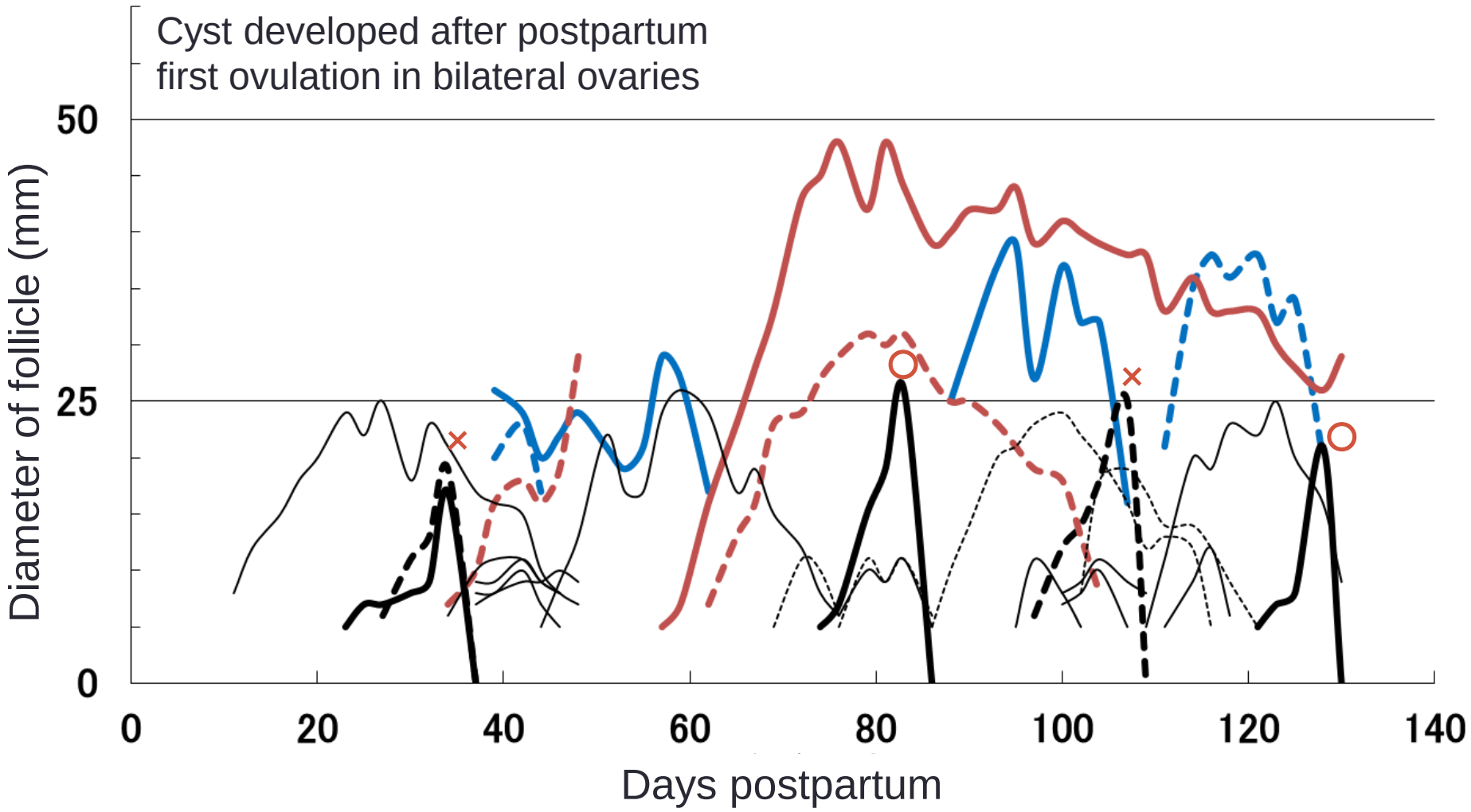
Follicular cyst - 4

Conception at D93 postpartum by the 1st AI

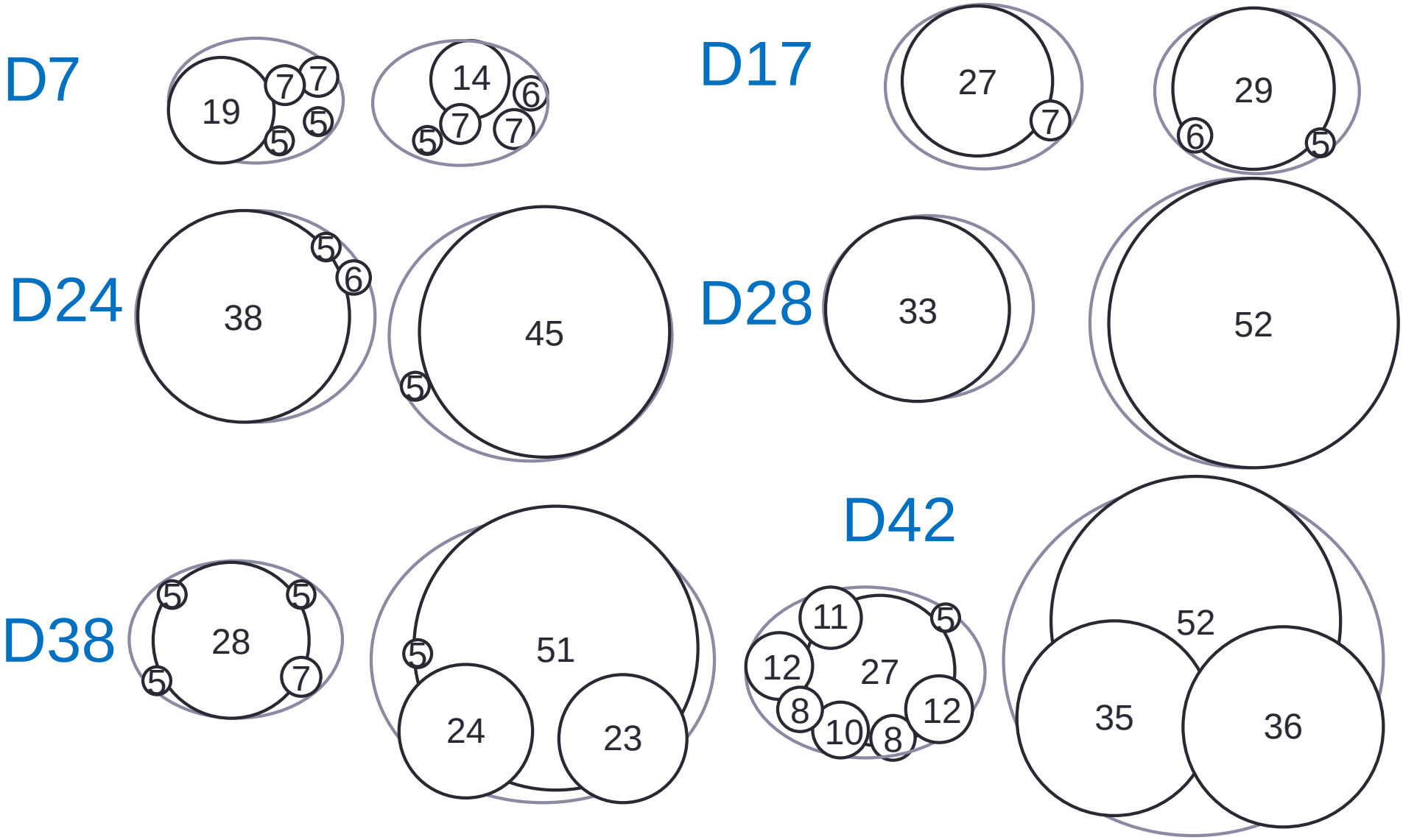


Follicular cyst - 5

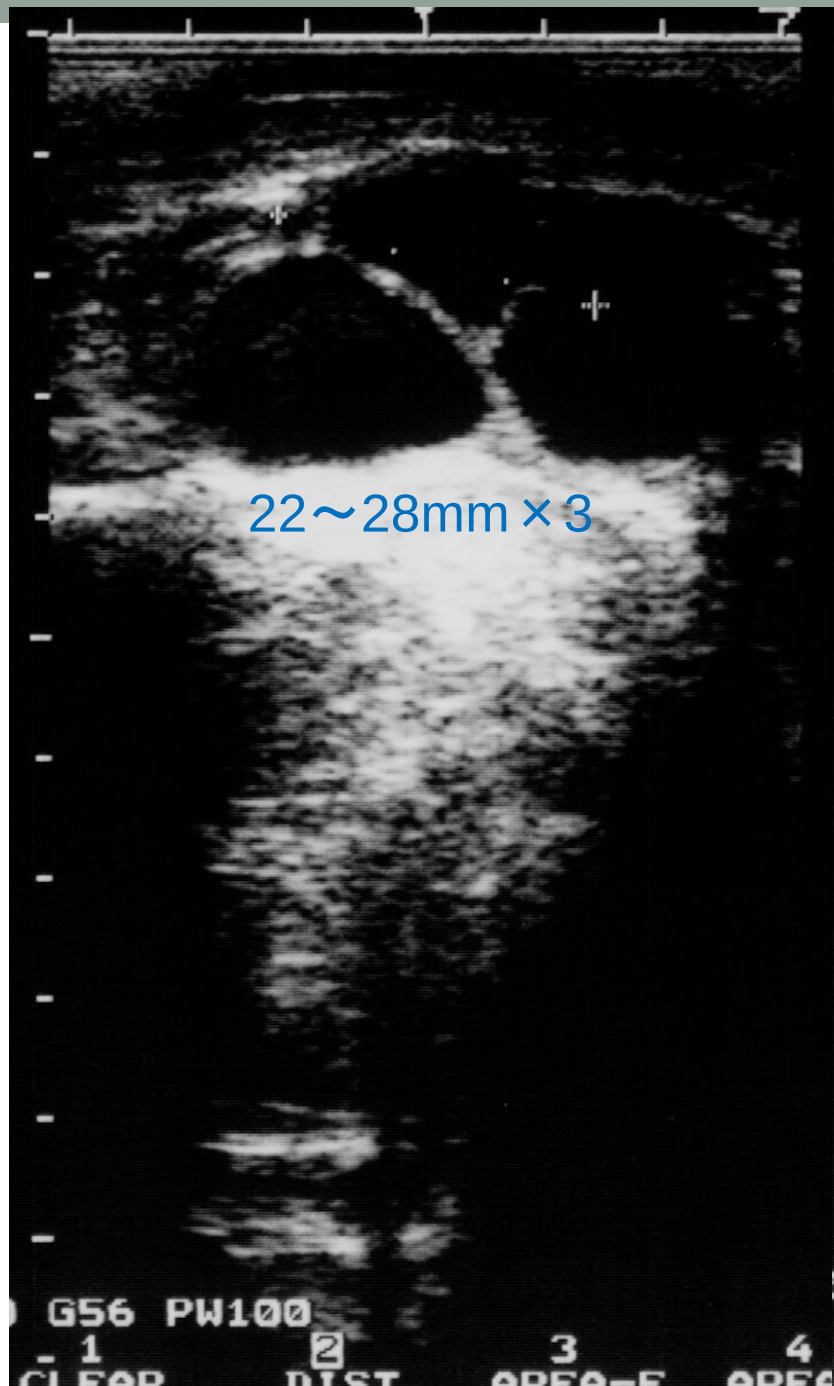
Conception at D129 postpartum by the 1st AI



Ovarian diagram of follicular cyst – 4 case



D47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G56 PW100
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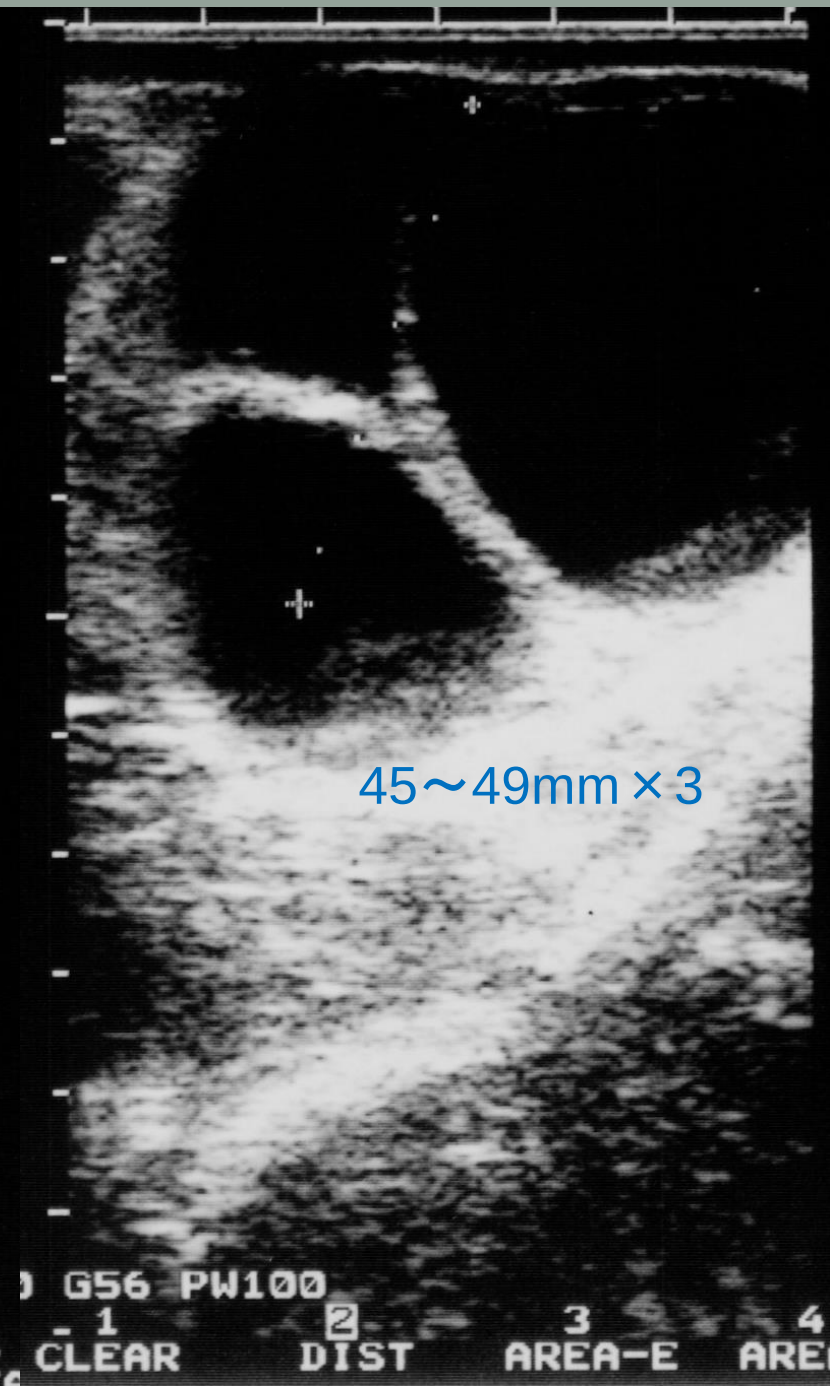
45～49mm×3
G56 PW100
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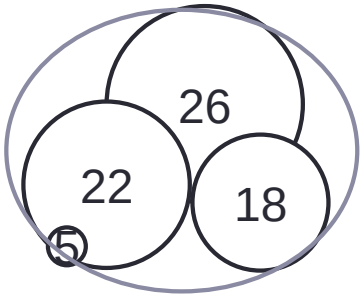
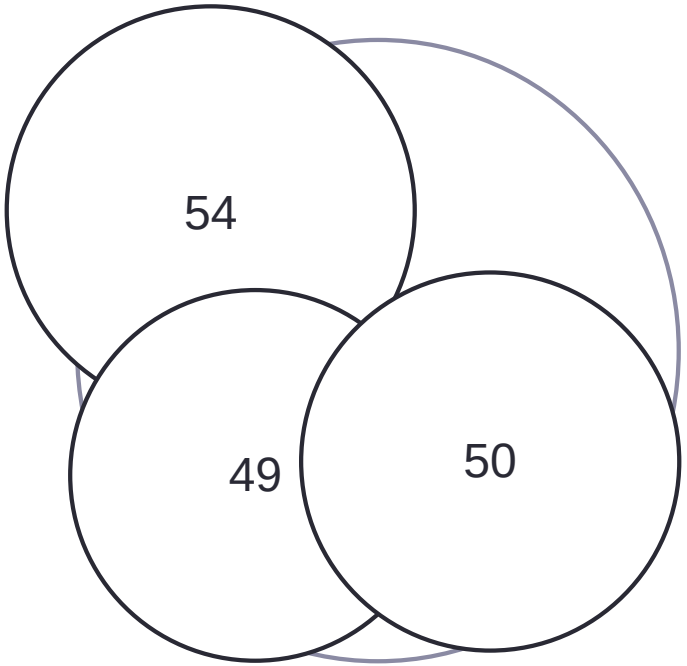
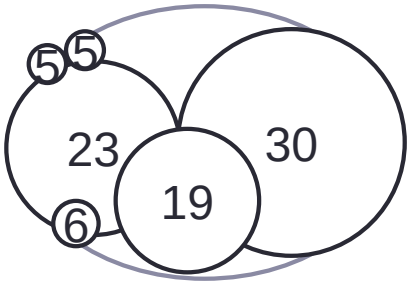
DIST
AREA-E

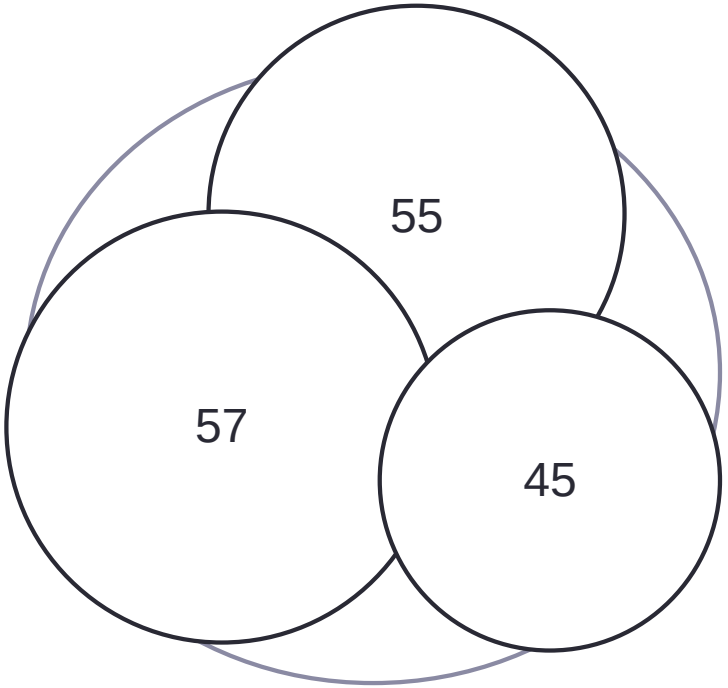
D45





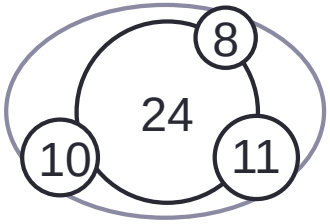
D54

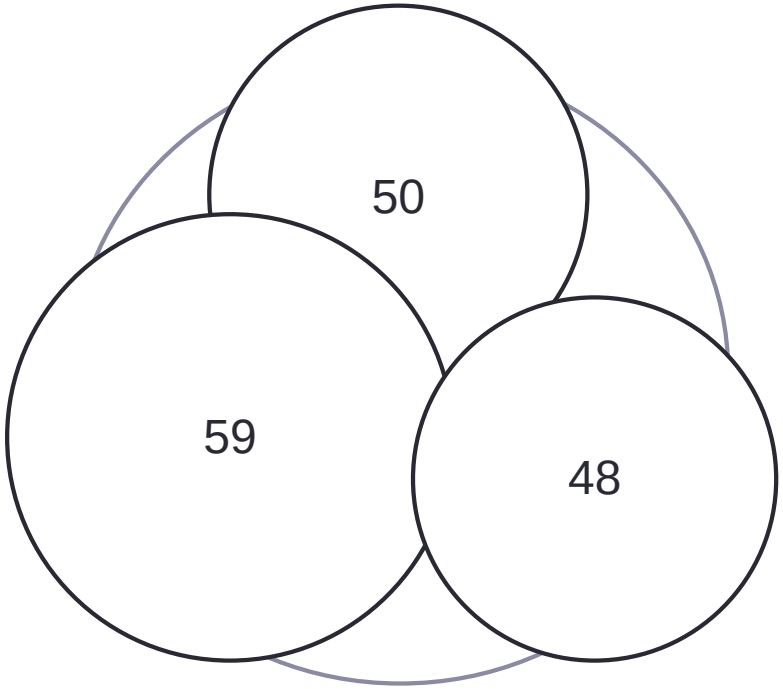




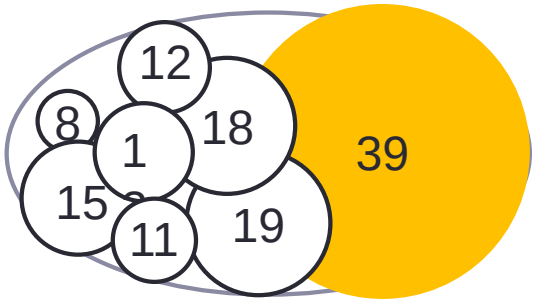
（**D55** anestrous ovulation）

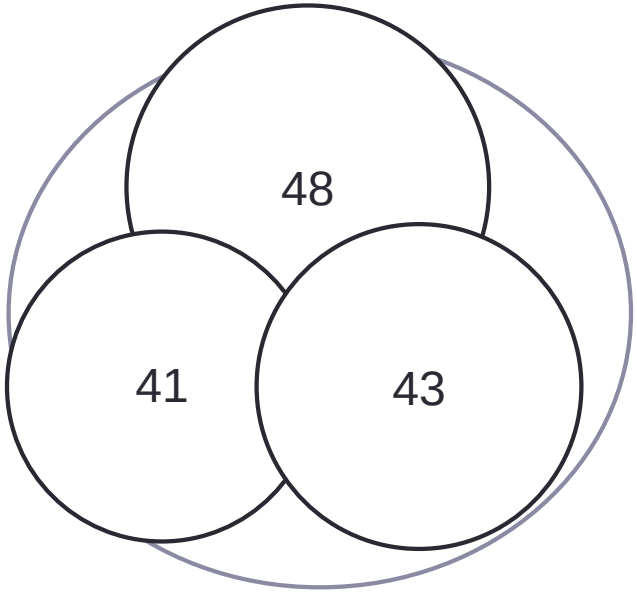
D56





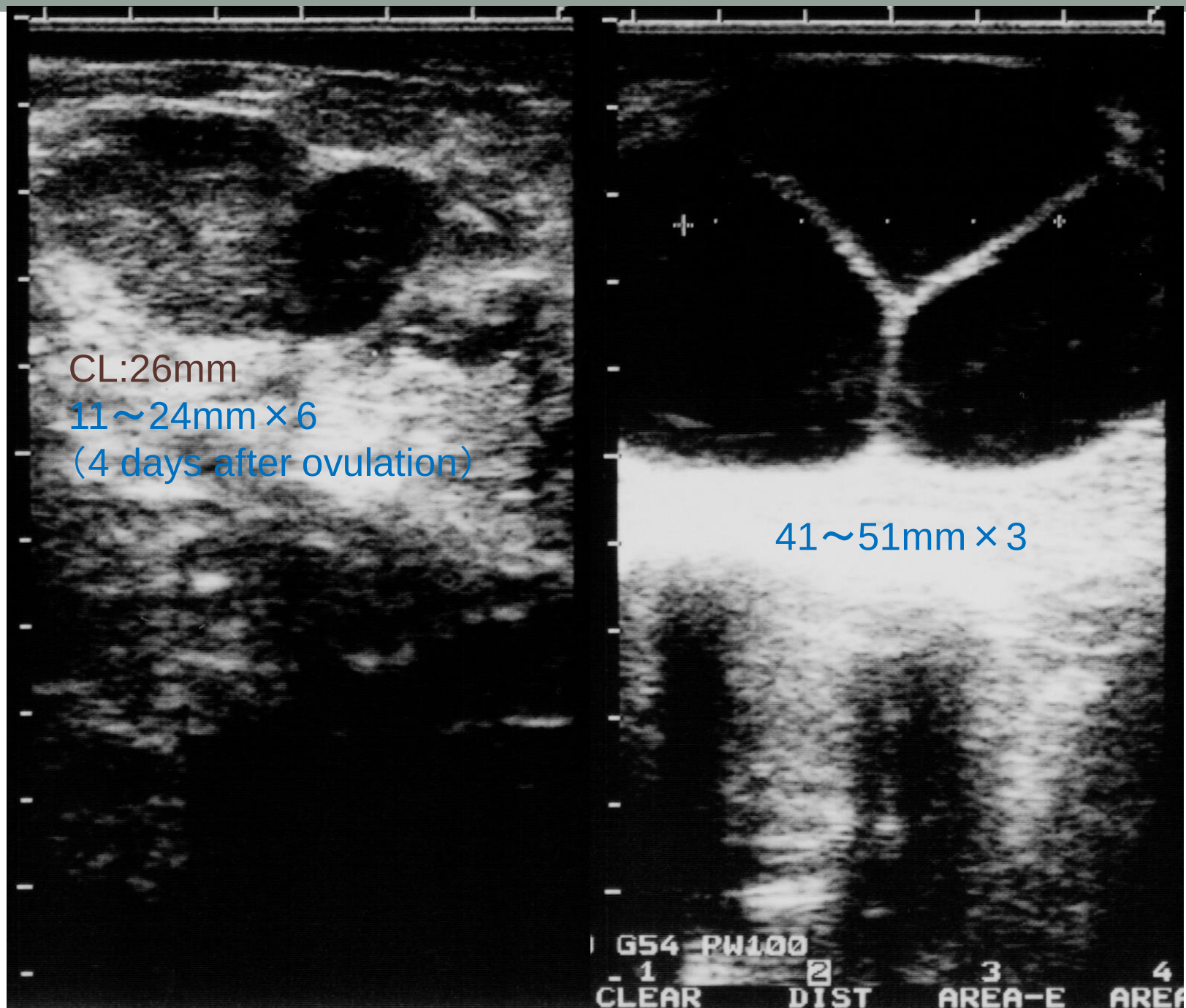
D70



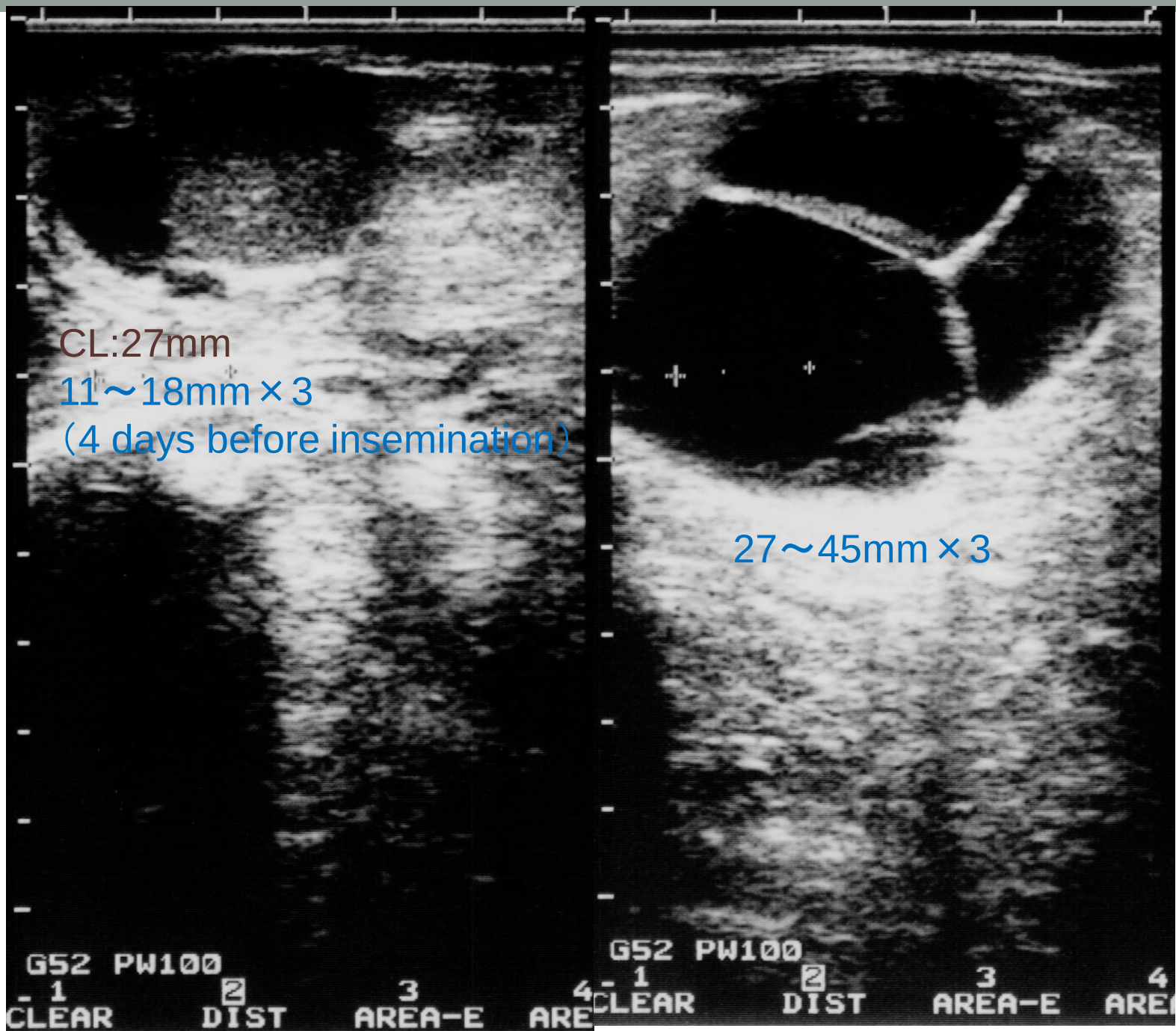


（**D74** anestrous ovulation）

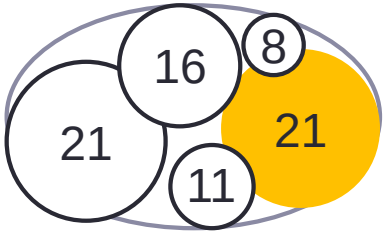
D61

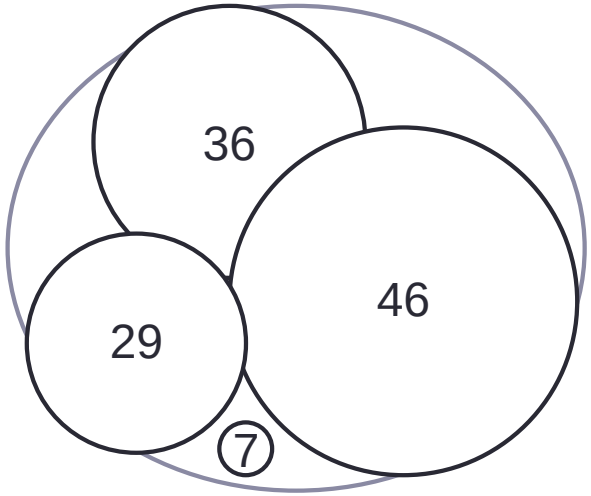

CL:26mm
11～24mm×6
（4 days after ovulation）
41～51mm×3
G54 PW100
1
2
3
4
CLEAR
DIST
AREA-E
AREA

D89


CL:27mm
11～18mm×3
（4 days before insemination）
27～45mm×3
G52 PW100
1 CLEAR
2 DIST
3 AREA-E
4 ARE
G52 PW100
1 CLEAR
2 DIST
3 AREA-E
4 ARE

D91



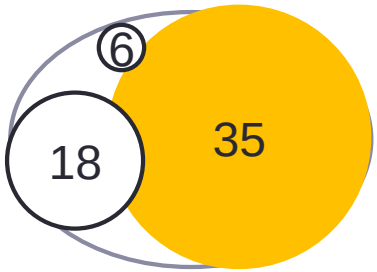


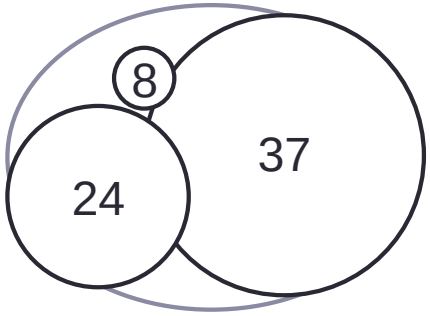
D92 Mounting heat ⇒ **D93** AI and ovulation

D129 at pregnancy diagnosis

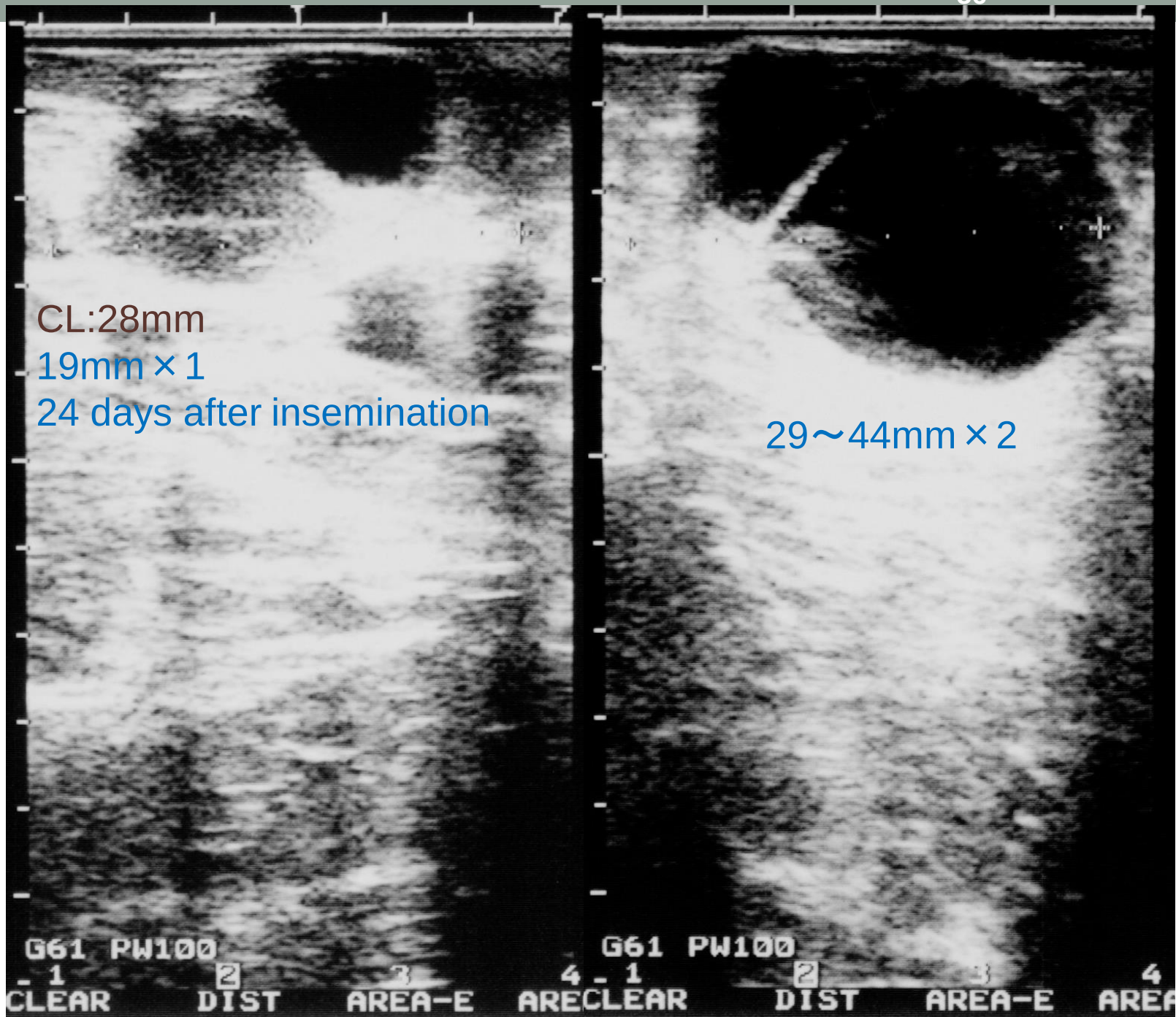
- If corpora lutea exist, "cysts" are harmless "ballons"

(Only pressing other ovarian tissues)





D117


CL:28mm
19mm×1
24 days after insemination
29～44mm×2
G61 PW100
1
2
3
4
CLEAR
DIST
AREA-E
ARE
G61 PW100
1
2
3
4
CLEAR
DIST
AREA-E
AREA

Anovulatory waves more than 4 times

- In 6 cows neither ovulation nor cyst formation

- Reflects some cases of “ovarian quiescence” ?

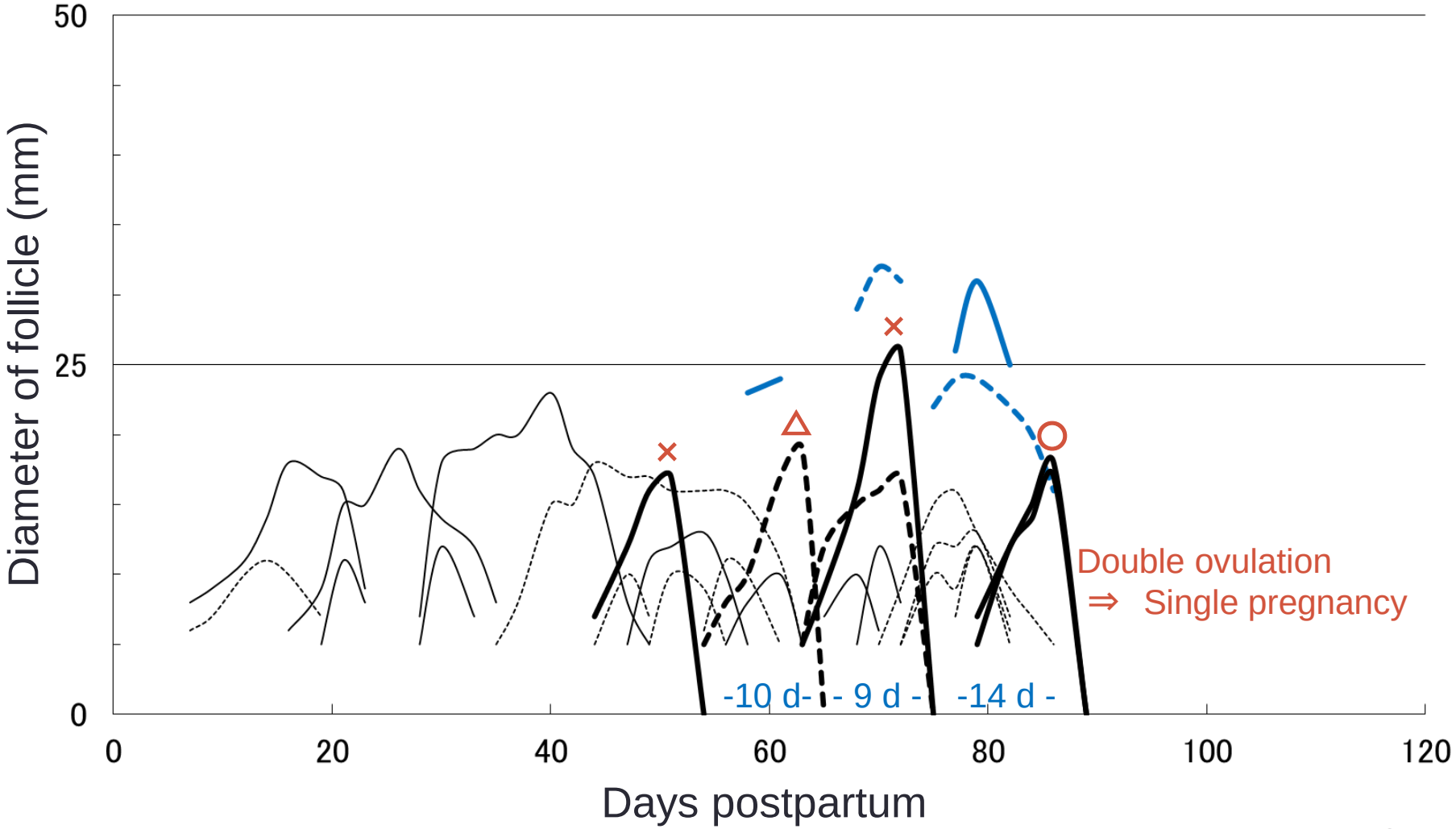
- Delays first ovulation

  ⇒ Late exposure of uterus to progesterone

  ⋯⋯⋯⋯⇒ Positive effects of uterine involution?

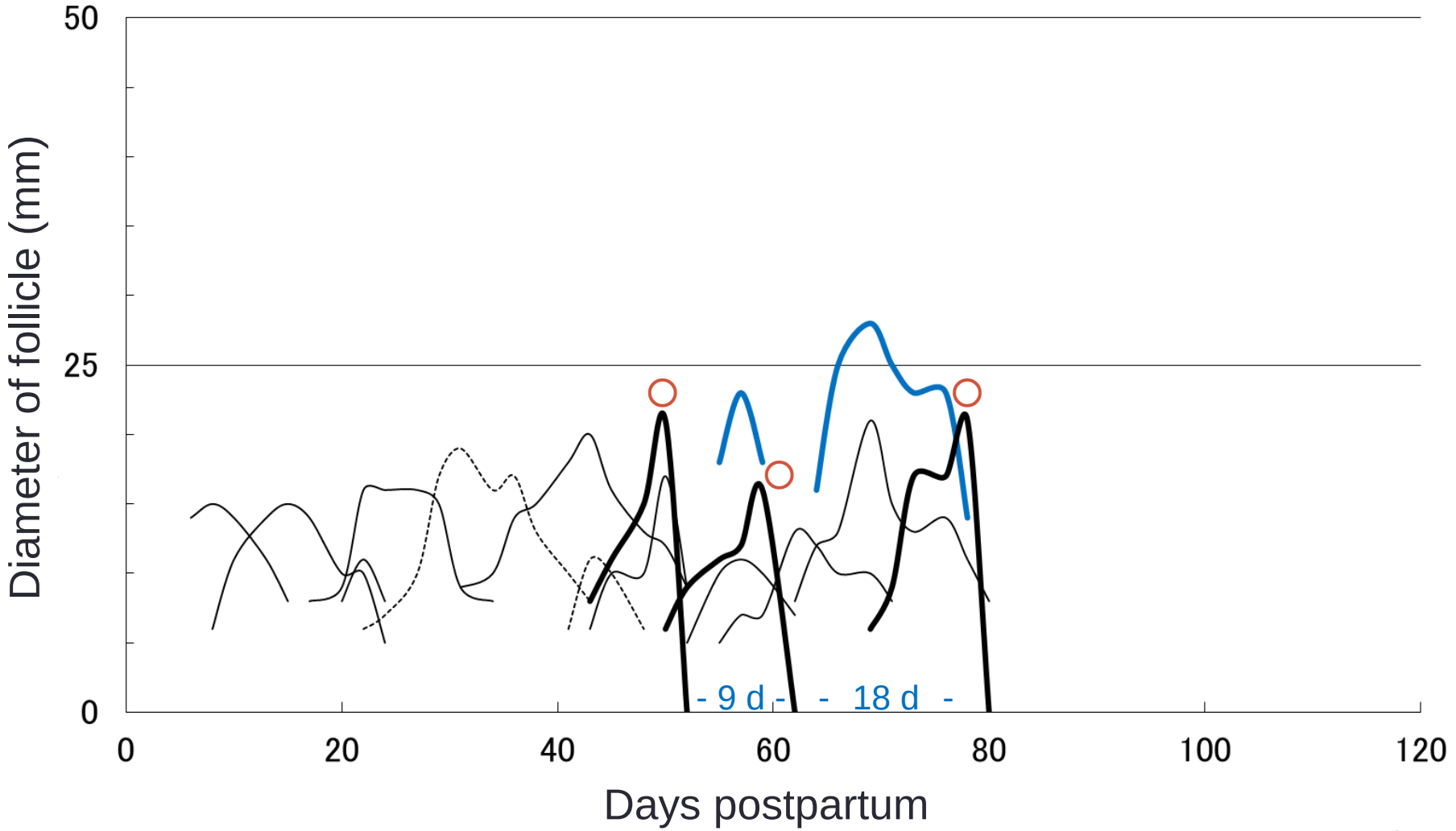
Ovulated at 5th wave

Conception at D87 postpartum by the 1st AI



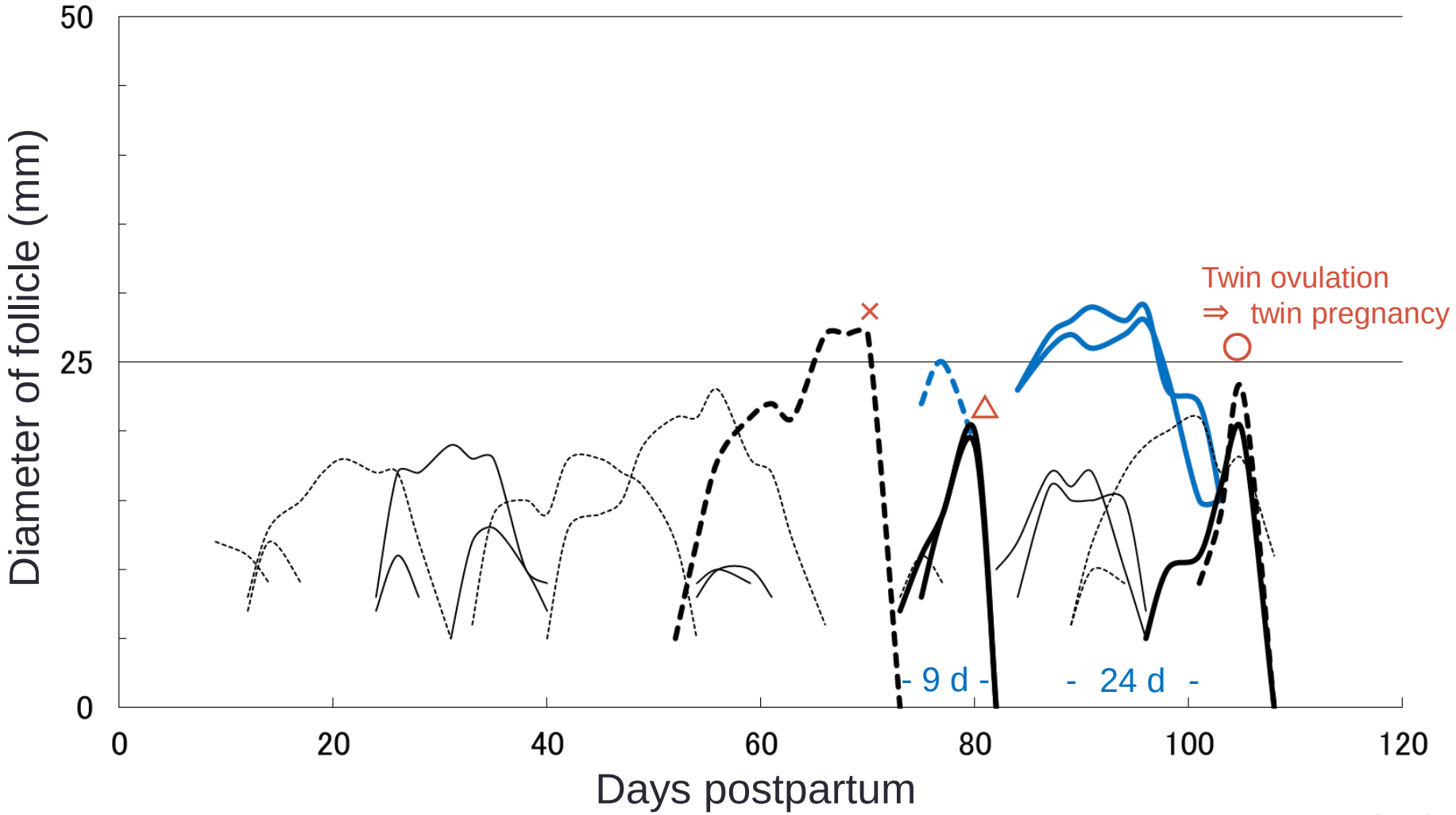
Ovulated at 6th wave -1

Conception at D79
postpartum by the 1st AI



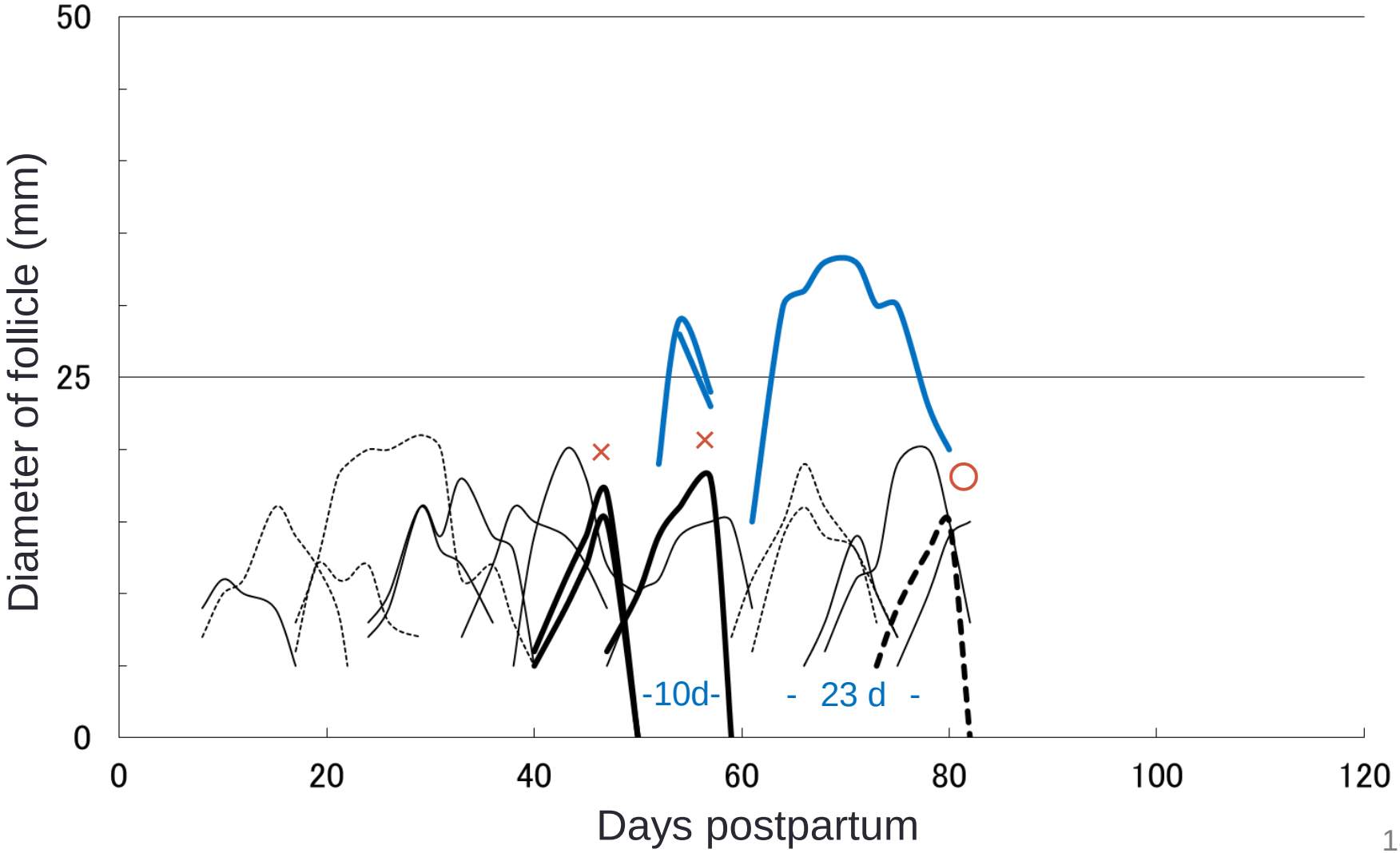
Ovulated at 6th wave -2

Conception at D105
postpartum by the 1st AI



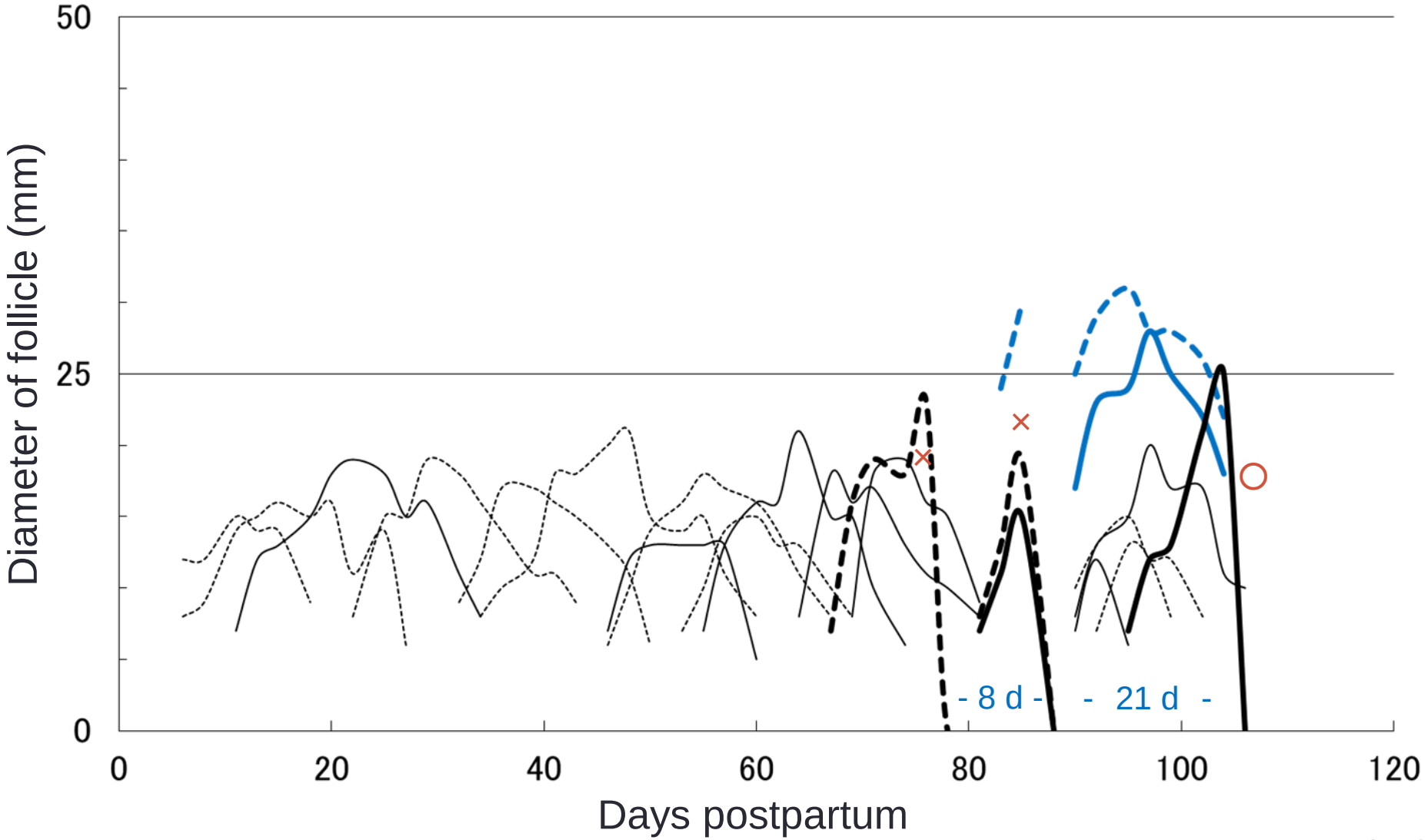
Ovulated at 7th wave

Conception at D81 postpartum by the 1st AI



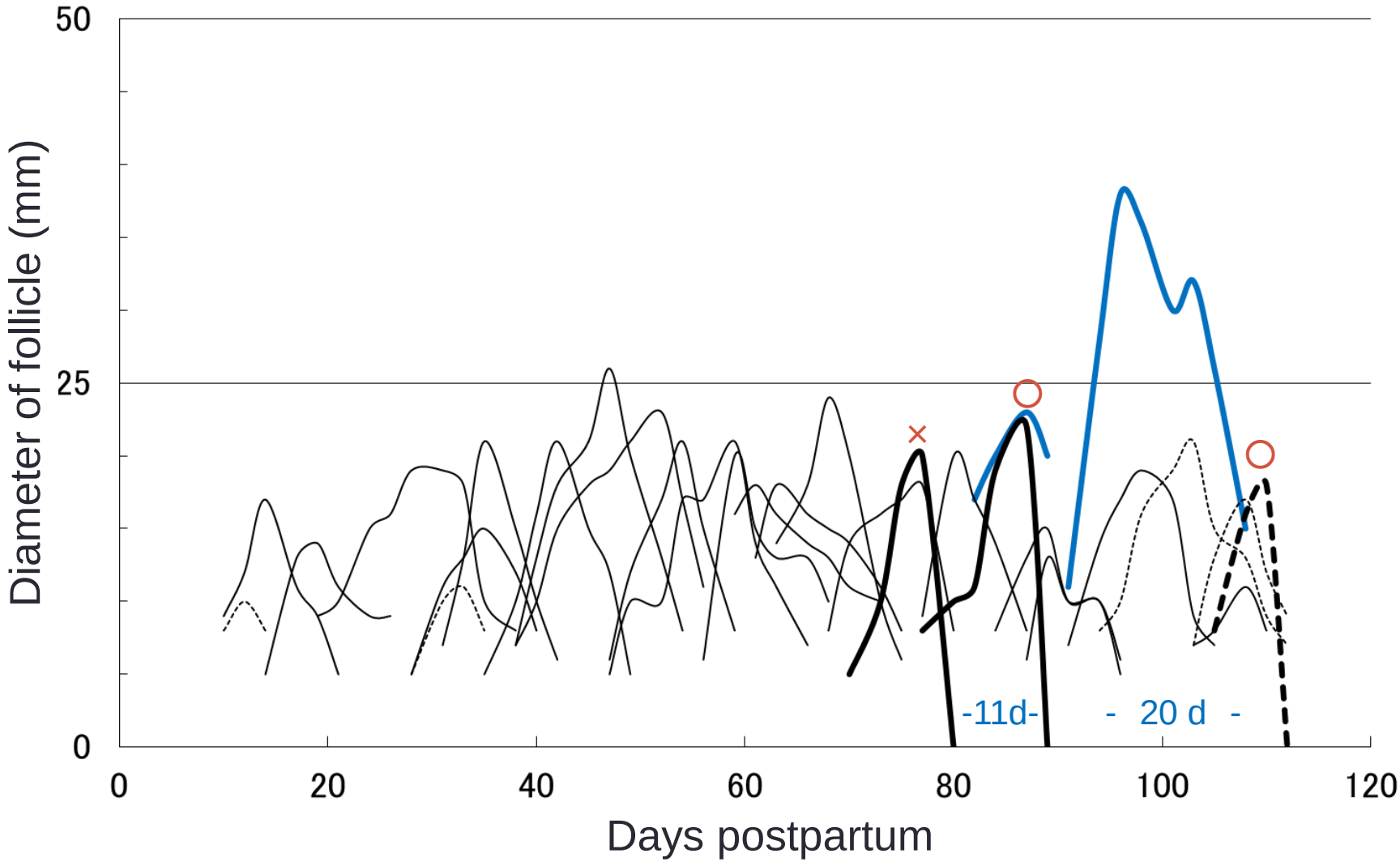
Ovulated at 10th wave

Conception at D107
postpartum by the 1st AI



Ovulated at 13th(?) wave

Conception at D110 postpartum by the 1st AI

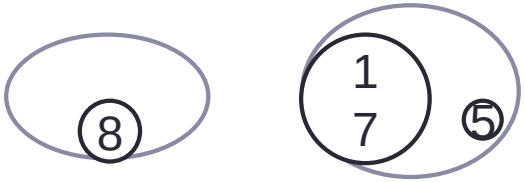


Ovarian diagram of follicular 13(?) wave case

D10

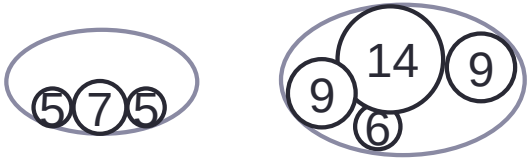
D12

D14



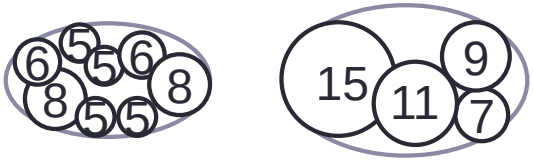
D17

D19



D21

D24

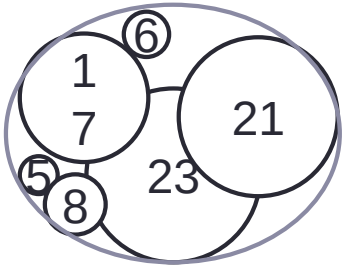


D26

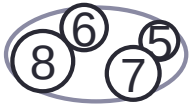
D35

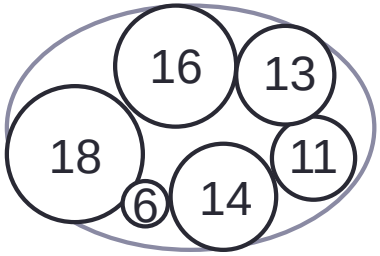
D45

D54

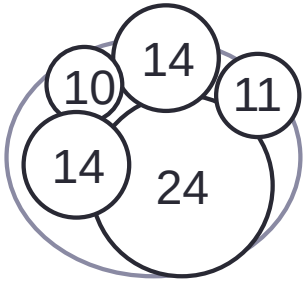


D63

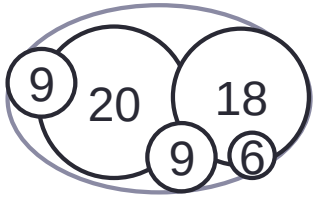




D70

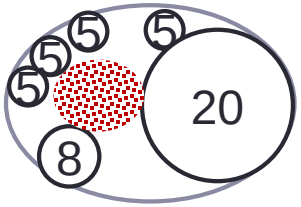


D77

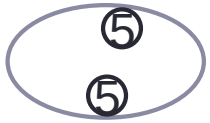


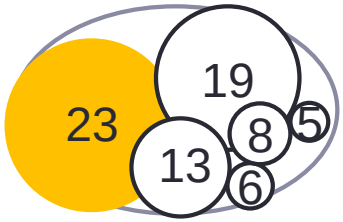
D79 無発情排卵

D80

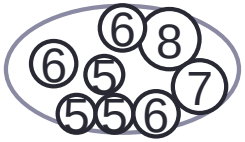


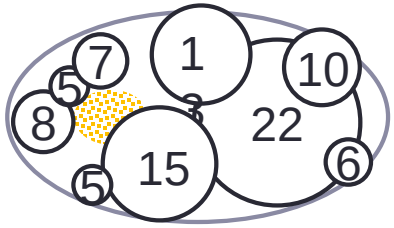
D87





D89



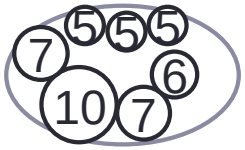


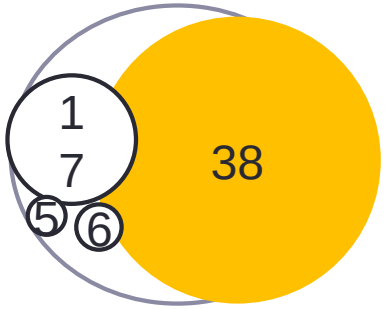
D89 Standing heat

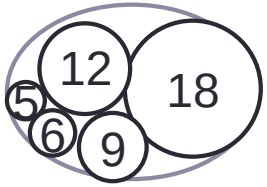
D90 Ovulation（not inseminated）

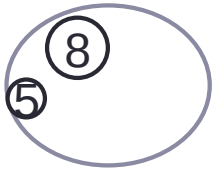
D110 **Heat**・AI・Ovulation ⇒ Conception

D96

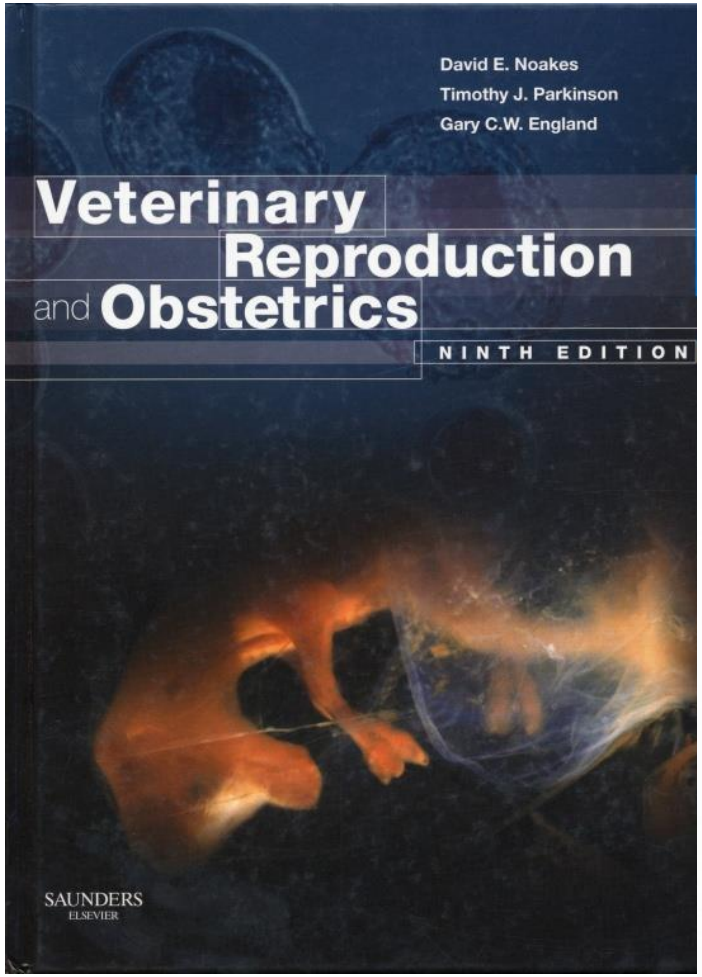








Follicular cysts
～Overview



9th Ed.（2009）

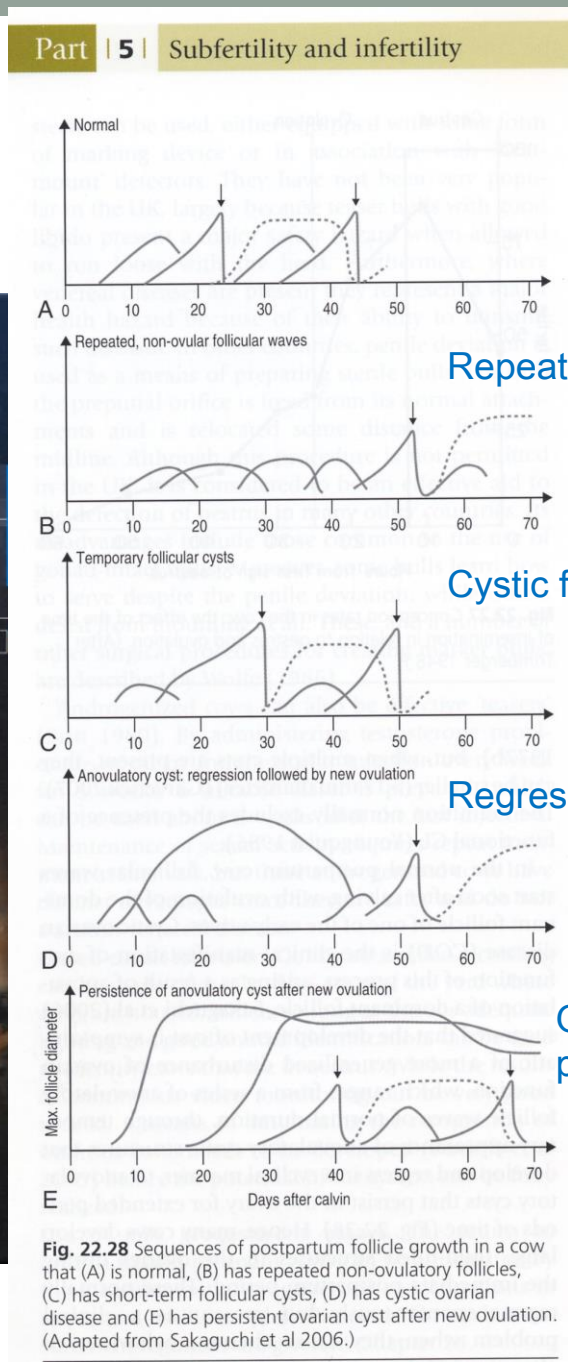


Fig. 22.28 Sequences of postpartum follicle growth in a cow that (A) is normal, (B) has repeated non-ovulatory follicles, (C) has short-term follicular cysts, (D) has cystic ovarian disease and (E) has persistent ovarian cyst after new ovulation. (Adapted from Sakaguchi et al 2006.)

Chapter 22 (Parkinson T）
Infertility and subfertility in the cow: structural and functional abnormalities, management deficiencies and non-specific infections

Repeated waves =
Ovarian quiescence ?

Cystic follicles

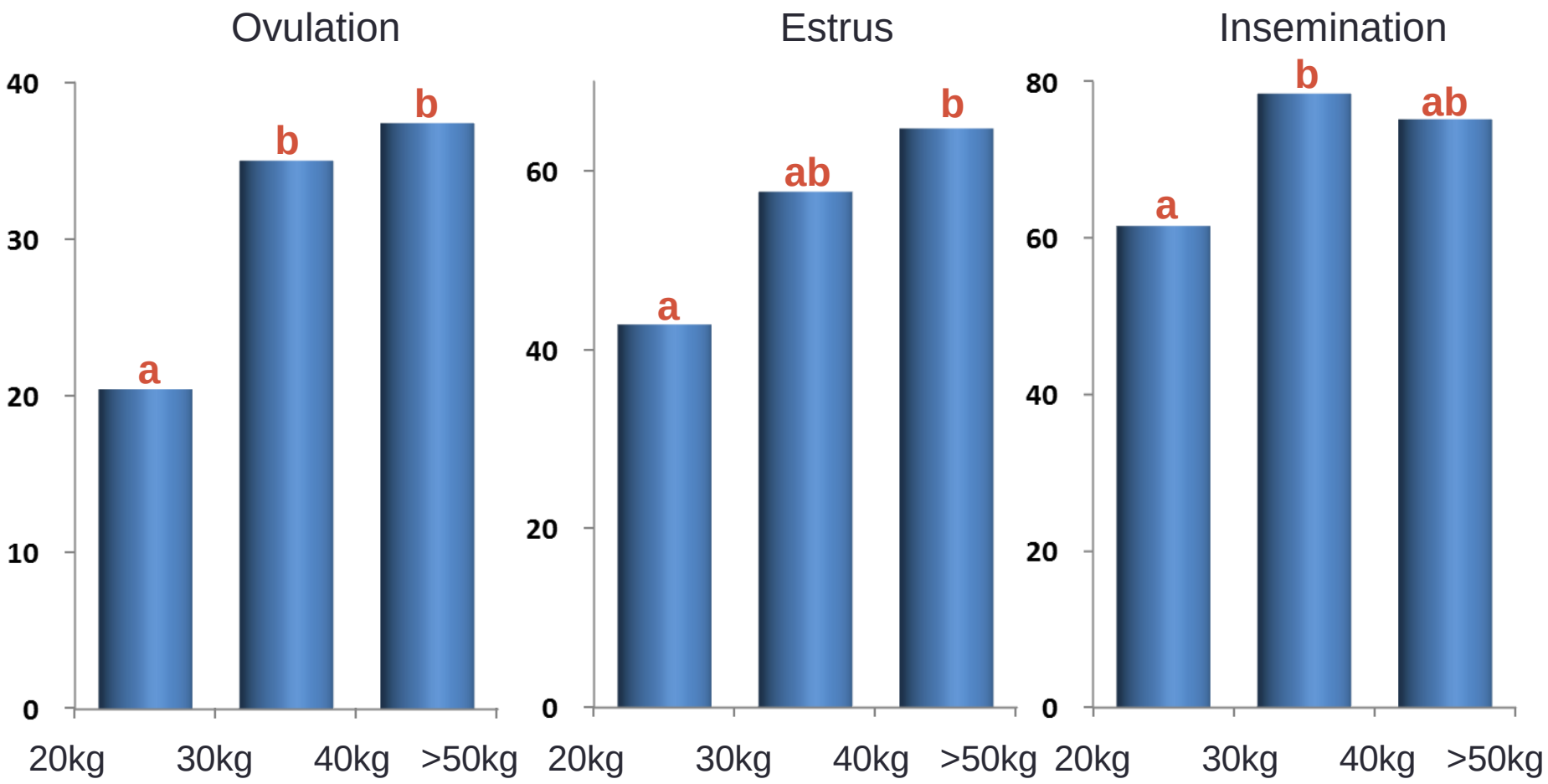
Regression followed by ovulation:
rare cases during early postpartum period ?

Ovulation under the existence of persistent cyst(s)
- Endocrinologicaly inactive
- Ultrasound examination to identify CLs

4. INDICES FOR FERTILITY AND ESTROUS DETECTION

Veterinary intervention or other approaches

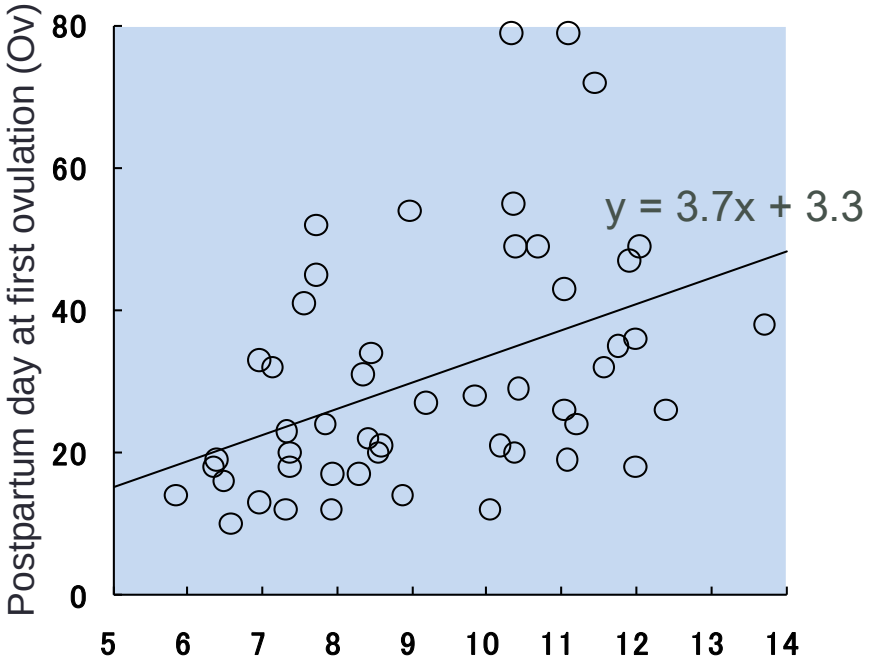
Effects of milk yield on fertility traits

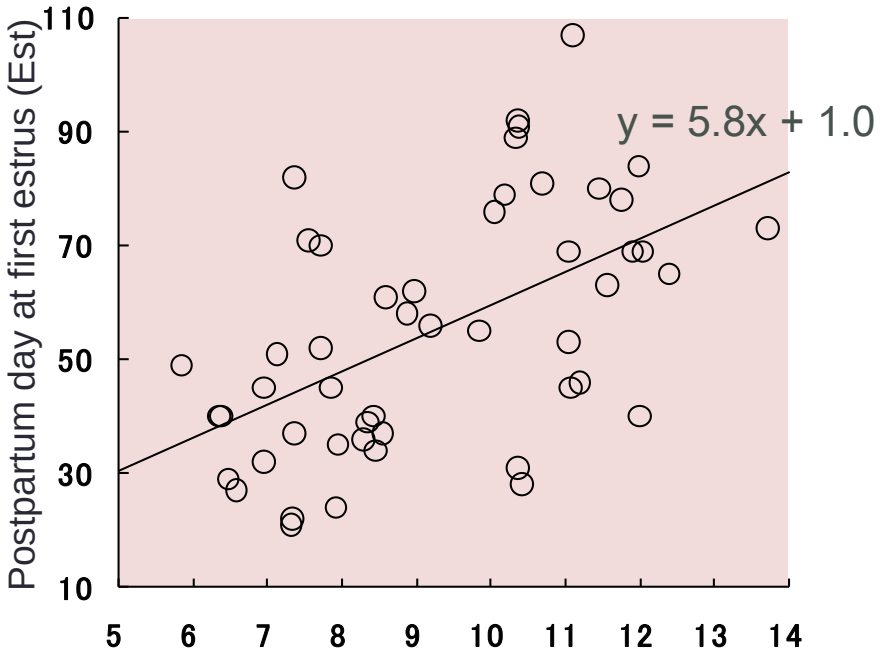


Mean milk yield during 10 weeks postpartum

Hokkaido Chikusan Gakkaiho (2003)

Relationship between milk yield and fertility





Milk yield (MY, ton)

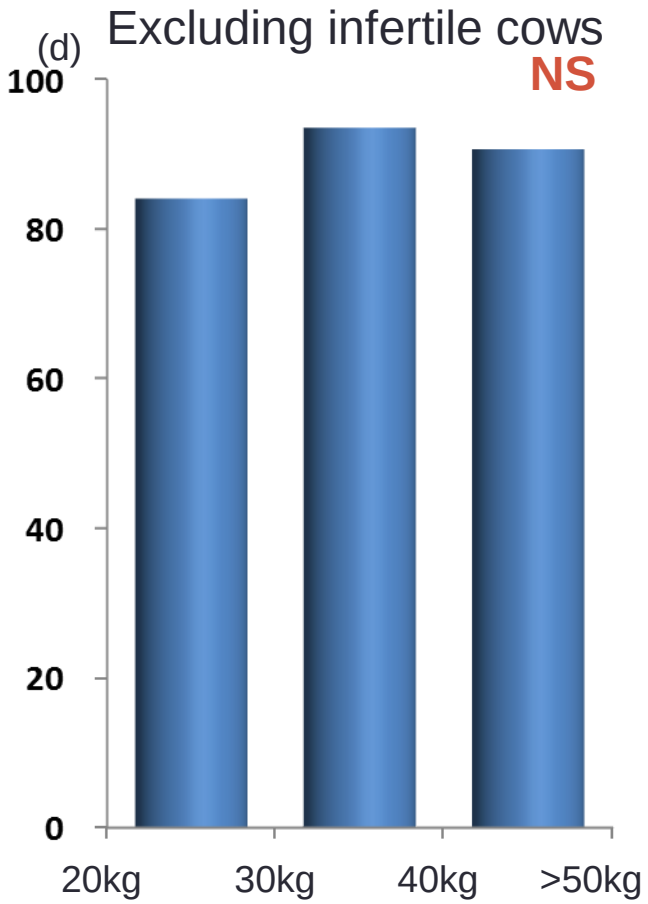
Mean Ov ≒ MY x 3.3 (10/3); Mean Est ≒ MY x 6

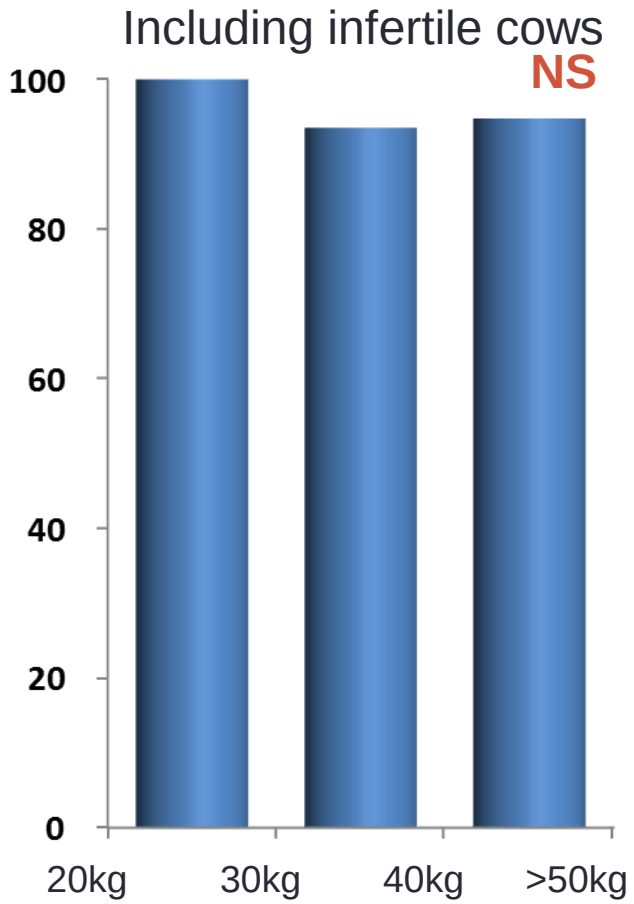
9,000kg, 30 d – 54 d; 12,000kg, 40 d – 72 d; 15,000kg, 50 d – 90 d

References for synchronization of estrous or ovulation and reproductive teratment

Nihon Chikusan Gakkaiho (2008)

Effect of milk yield on days open



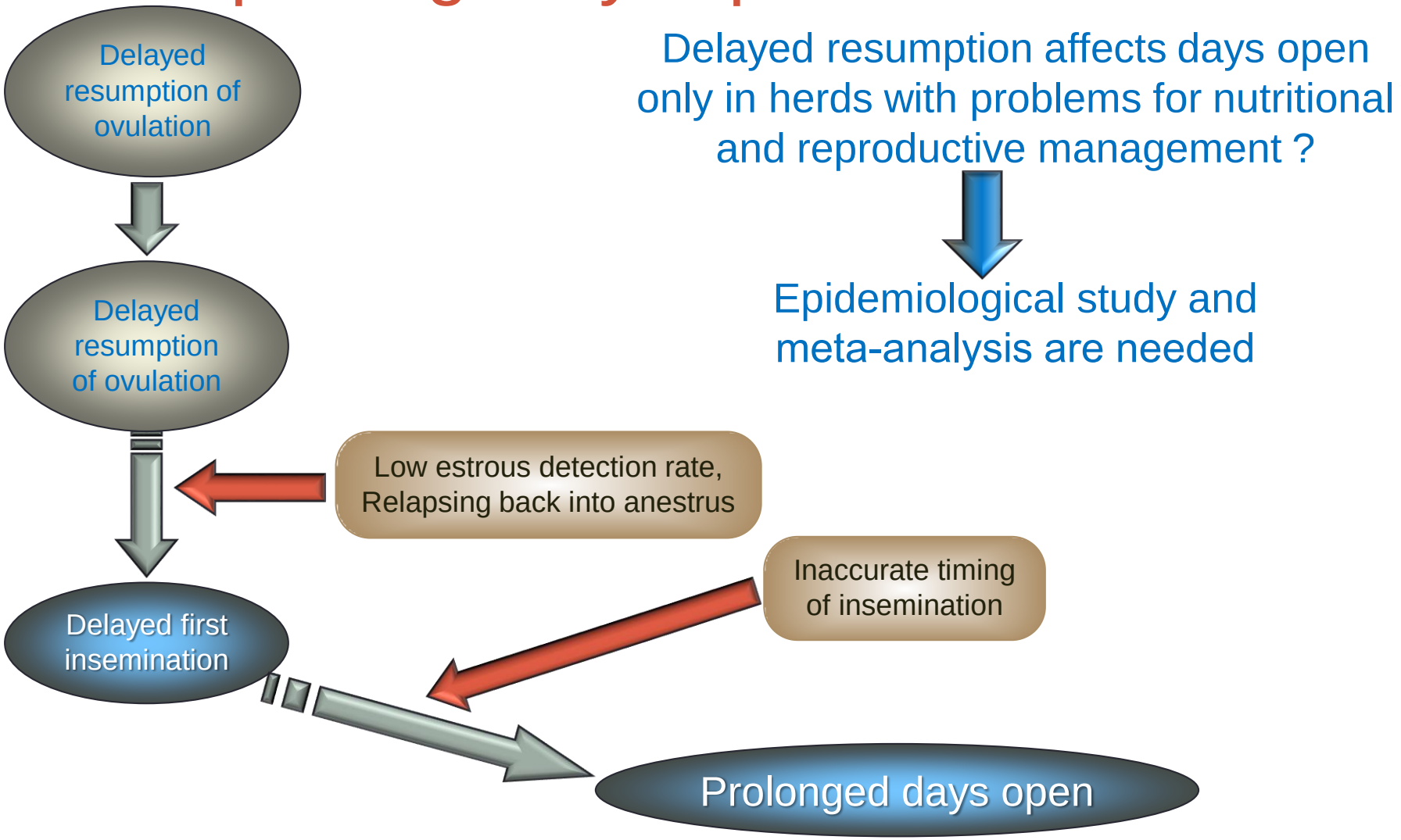


	20kg	30kg	40kg	>50kg
Conception rate	82% (3/17)	100% (0/15)	89% (2/18)	

*Cows without a positive pregnancy diagnosis by 180 days in milk were assigned a days open value equal to 21 days after their last unsuccessful service

Hokkaido Chikusan Gakkaiho (2003)

Delayed resumption of ovulation and/or estrus prolongs days open?



Changes in BCS and fertility

- BCS reflects energy balance (feed intake – milk yield)
  - A practical index for energy balance
  - Body fat mobilization ⇒ body protein mobilization
  - Time lags: monitoring weekly chanses
- The score itself could not be any indices
- Significant correlation with relative values
  - Intervals to first ovulation: positive correlation with postpartum days at BCS nadir
  - Intervals to first estrus: positive correlation with maximum BCS loss
  - Intervals to first insemination and days open: no signisicance

Can Vet J (2009)

Relative values of BCS and BW (effects of parity)

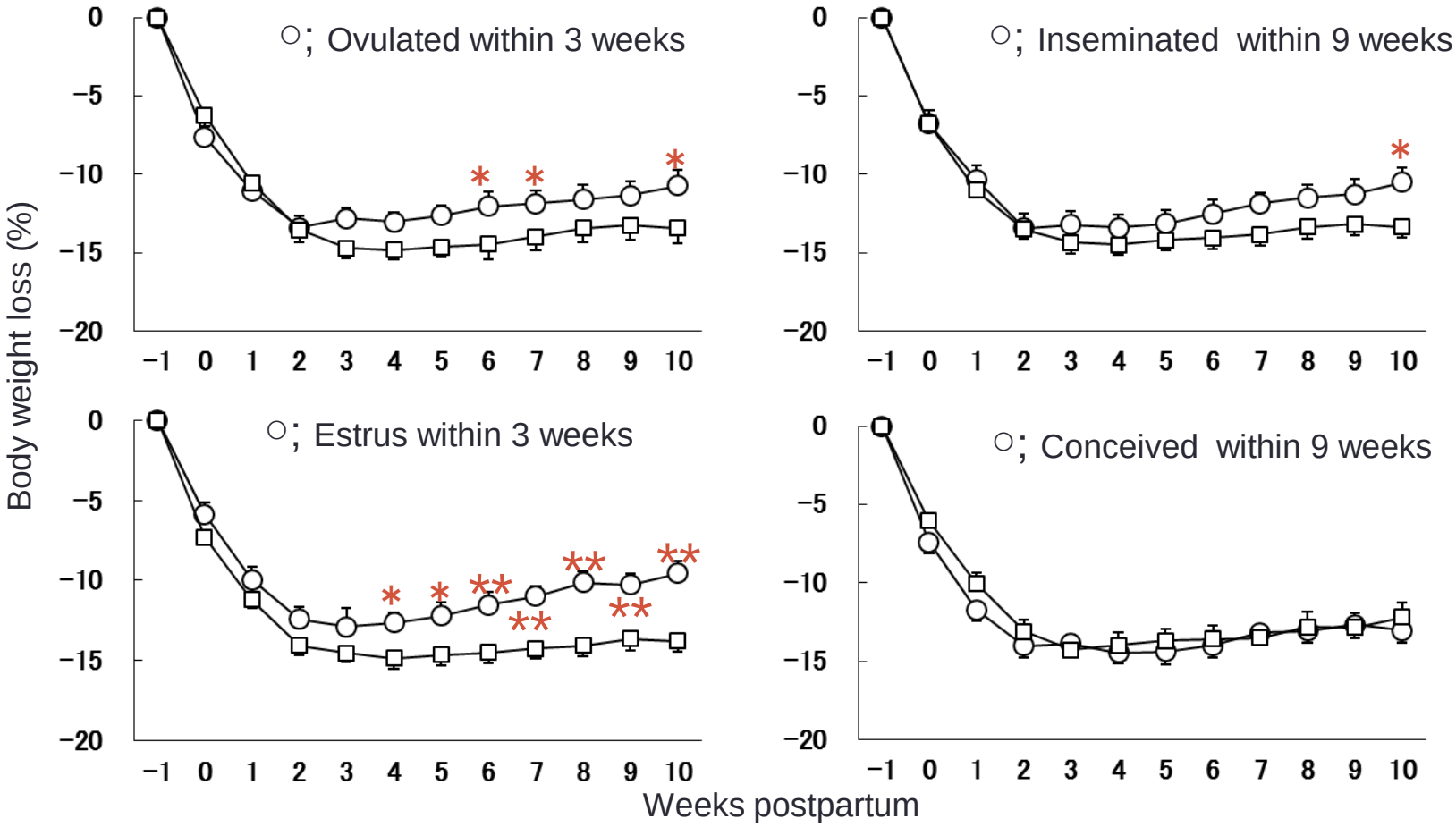
	Primiparous	Multiparous	Total
BCS loss	-0.55 ± 0.16[a]	-0.71 ± 0.31[b]	-0.62 ± 0.25
BCS nadir, d	45.2±20.0[a]	58.2 ± 19.2[b]	51.4 ± 20.5
BW loss (%)	-15.5 ± 3.8	-17.0 ± 4.3	-16.2 ± 4.1
BW nadir, d	30.0 ± 16.3	32.9 ± 15.8	31.4 ± 16.0

BW includes gastrointestinal contents
= reflects feed intake

Parity has no effects on BW loss and BW nadir

Can Vet J (2009)

Body weight loss and fertility traits



Early ovulated, estrus expressed and inseminated cows showed rapid recovery of body weight, but early conceived did not

Can Vet J (2009)

The Use of Liveweight Change as an Indicator of Oestrus in a Seasonally Calving, Pasture-Fed Dairy Herd

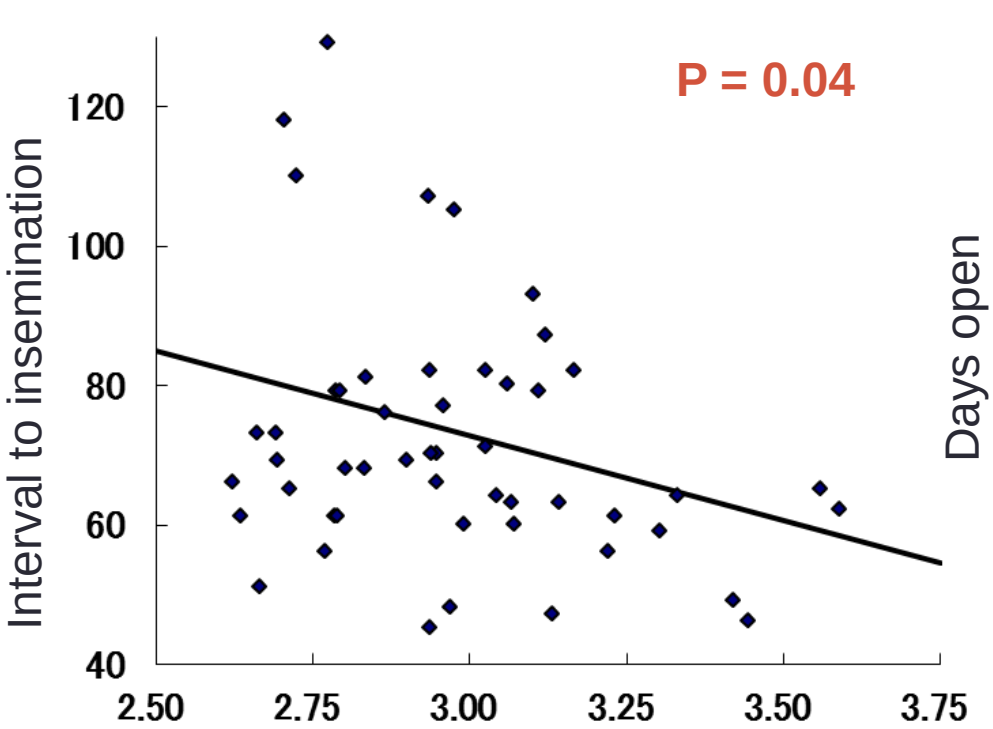
JI Alawneh[1,*], MA Stevenson[1], NB Williamson[1] and N Lopez-Villalobos[2]

[1]*EpiCentre, Institute of Veterinary, Animal and Biomedical Scie*
Animal and Biomedical Sciences, Massey University, Palmersto

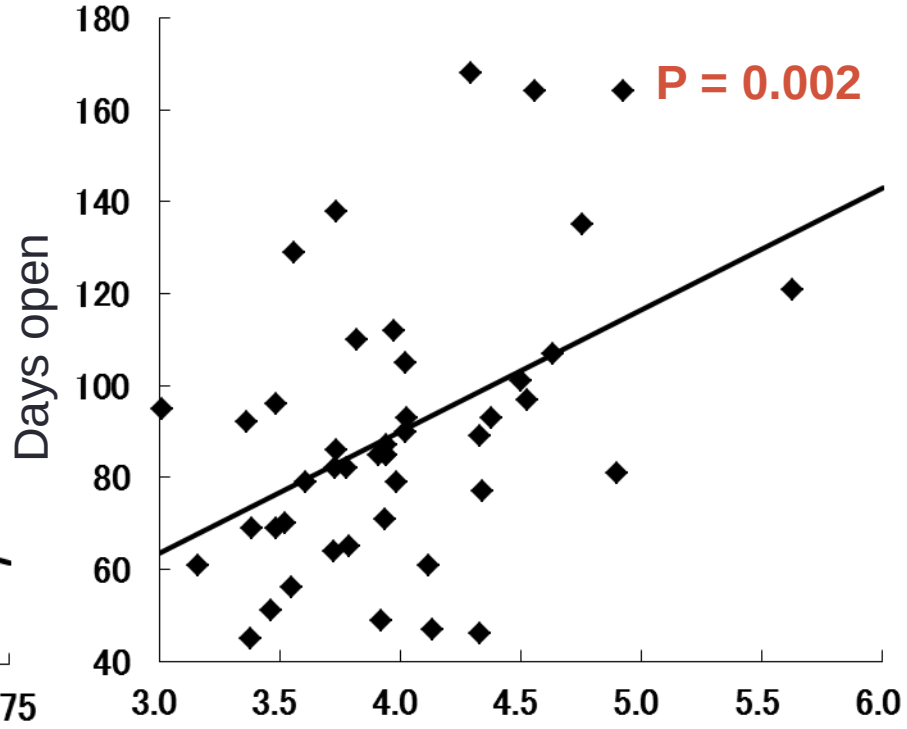
This was an observational study of 828 lactations in 542 mixed-age dairy cows that calved seasonally in a single, pasture-fed herd in New Zealand in 2008 and 2009. The study objectives were to: (i) document daily liveweight change (ΔLW) before and after observed oestrus for cows subsequently diagnosed pregnant or non-pregnant and (ii) quantify the sensitivity and specificity of ΔLW as a test for oestrus. The sensitivity and specificity of ΔLW when combined with other commonly used oestrous detection methods was also evaluated. In cows that conceived as a result of service at detected oestrus, liveweight loss began 1 day before the day of detection and was greatest on the day of detection (−9.6 kg, 95% CI −11.3 kg to −7.8 kg; $p < 0.01$) compared with LW recorded 2 days before the day of detection. In cows that did not conceive to a service at a detected oestrus, the lowest liveweights were recorded 1 day before the day oestrus was detected (−4.3 kg, 95% CI −7.7 to −0.8 kg; $p = 0.02$) compared with LW recorded 4 days before the day of detection. The sensitivity and specificity of ΔLW as a means of oestrous detection were 0.42 (95% CI 0.40–0.45) and 0.96 (95% CI 0.95–0.97), respectively. When ΔLW was combined with tail paint and visual observation, the oestrous detection sensitivity and specificity were 0.86 and 0.94, respectively. Monitoring LW change holds promise to enhance the sensitivity and specificity of oestrous detection in combination with other oestrous detection methods.

- Reprod Dom Anim (2014)
- New Zealand, automatic body weight measurement at milking
- Body weight losses around estrous detection
- Combined use of other estrous detection methods improves estrous detection efficiency

Milk composition as indices for reproductive traits



Milk protein (%) at 1 month postpartum
--- too early ?



Milk fat (%) at 4 month postpartum
--- too late ?

Nihon Chikusan Gakkaiho (2008)

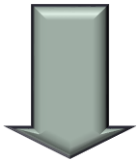
Lately expressed estrus: practical prospects

- Too late ovarian resumption and frequent anestrous ovulations

  ex) First ovulation at D98 ⇒ insemination at D105)

  ⇒ conception

  To detect rare estrous expression and to inseminate timely



- Ovulation synchronization or using estrous detection aids

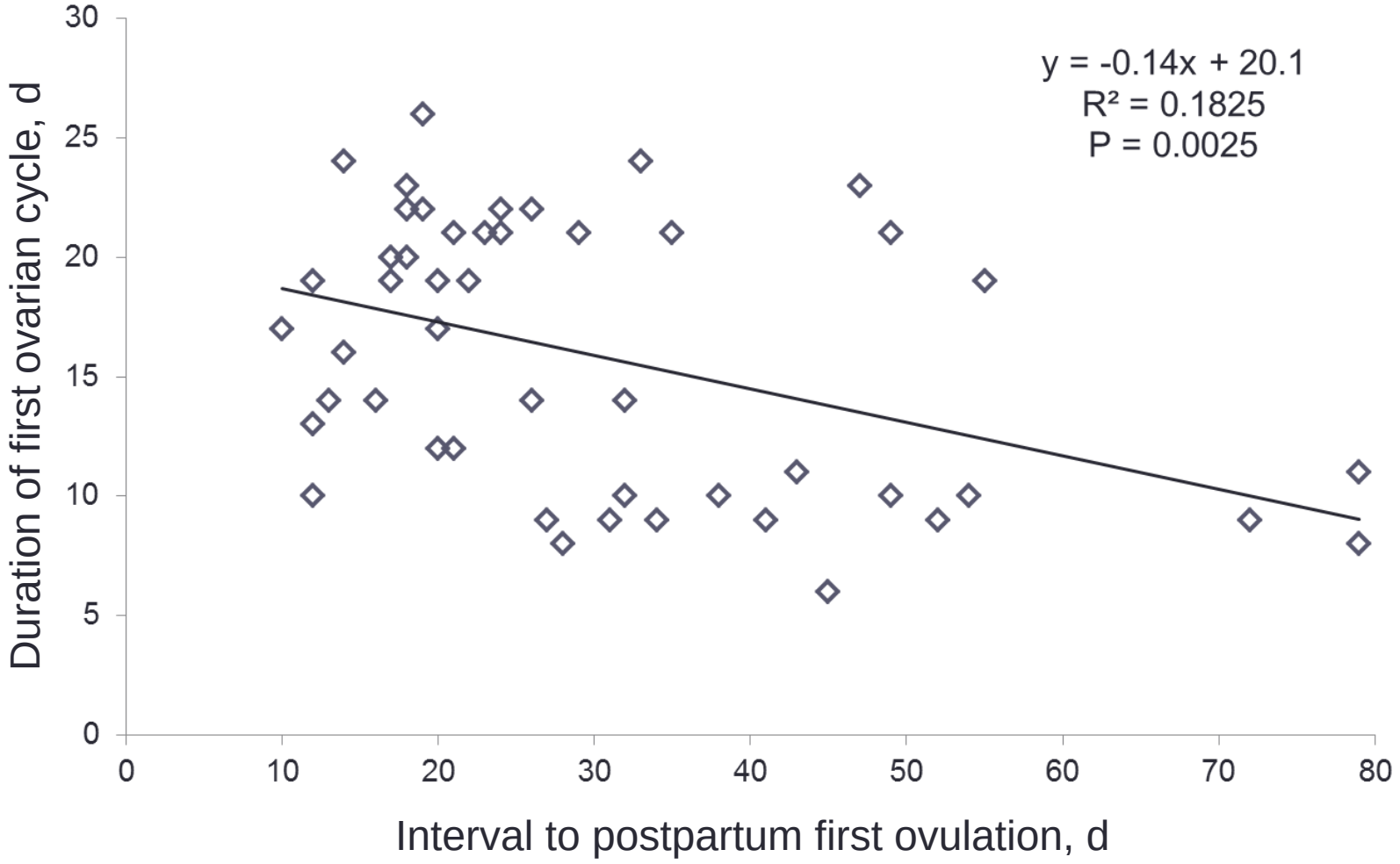
- Small herd in Japan,

  Economically proper ?

  Observation of individual cow is essential – to maintain farmers' skill

  Hormonal treatment should be limitted

Late ovarian resumption followed by short ovarian cycle



Effectiveness of hormonal treatment for non-disease cases

- Estrous synchronization: simple PG or CIDR

  Effective only for lowered estrous detection rate

  Estrous expression during expected few days

  ⇒ Concentration of estrous detection labor

- Ovulation synchronization: combination of PG, GnRH, CIDR or E_2

  Effective only for lowered insemination rate or insemination at improper timing

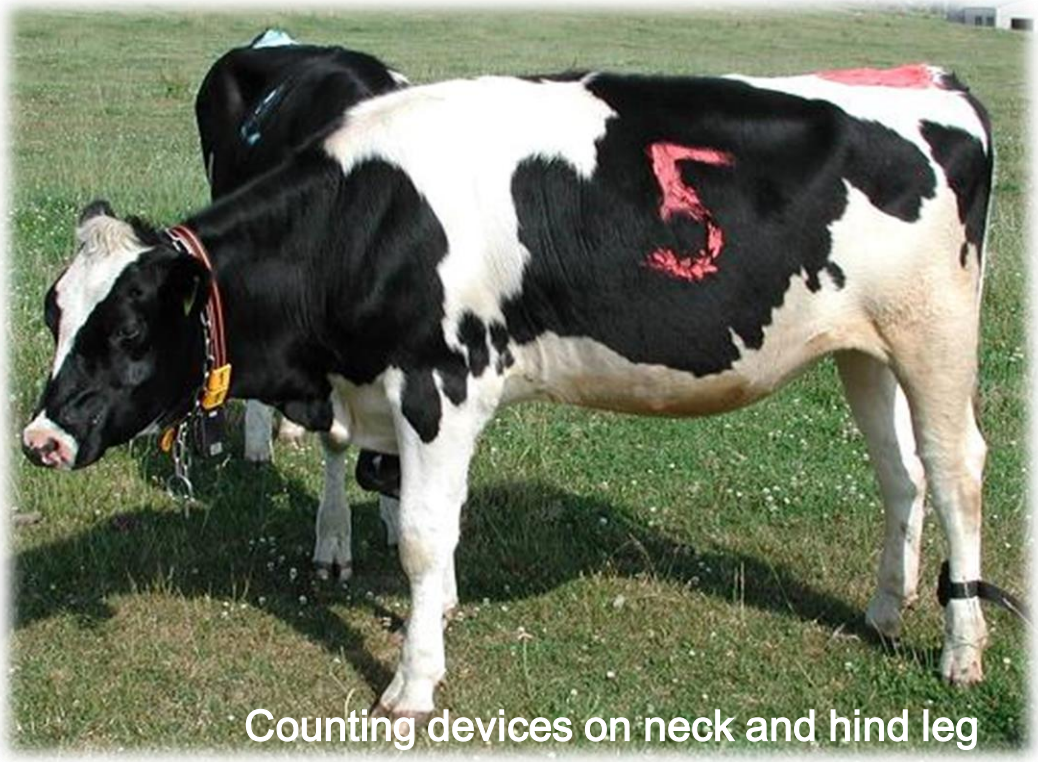
  Induced ovulation during expected hours

  ⇒ Insemination at almost proper timing

How to predict effective cases?

……. Some cases seems to be not effective and inappropriate

Estrous detection by using radiotelemetric pedometry system

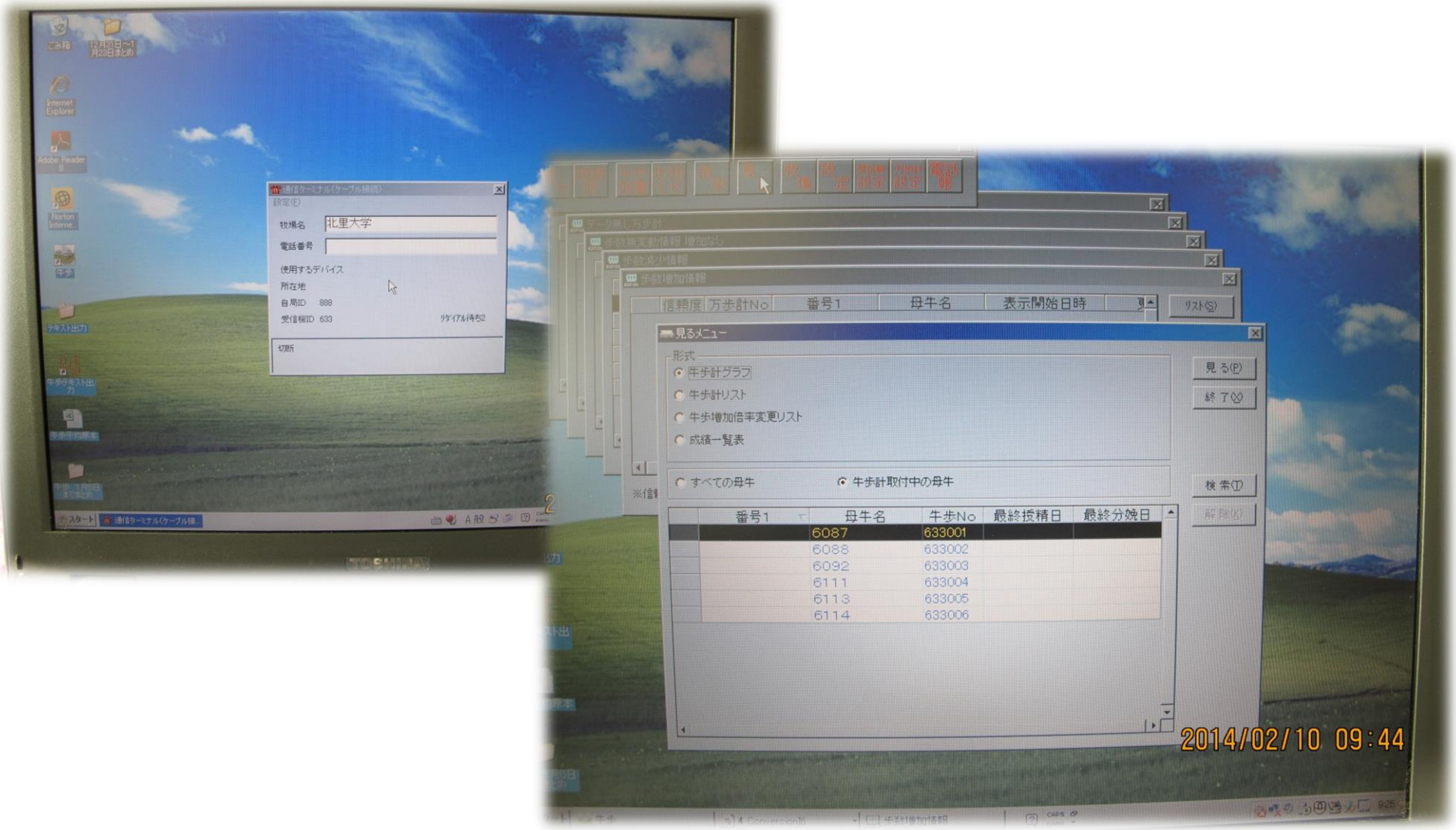


- Set threshold（% elevated or SD from mean counts）
  - Loose threshold ⇒ sensitivity↑(false negative↓), specificity↓(false positive↑)
  - Strict threshold ⇒ sensitivity↓(false negative↑), specificity↑(false positive↓)
  - Best threshold depends on the herd condition and environment
    ⇒ Calibration for each herd is indispensable

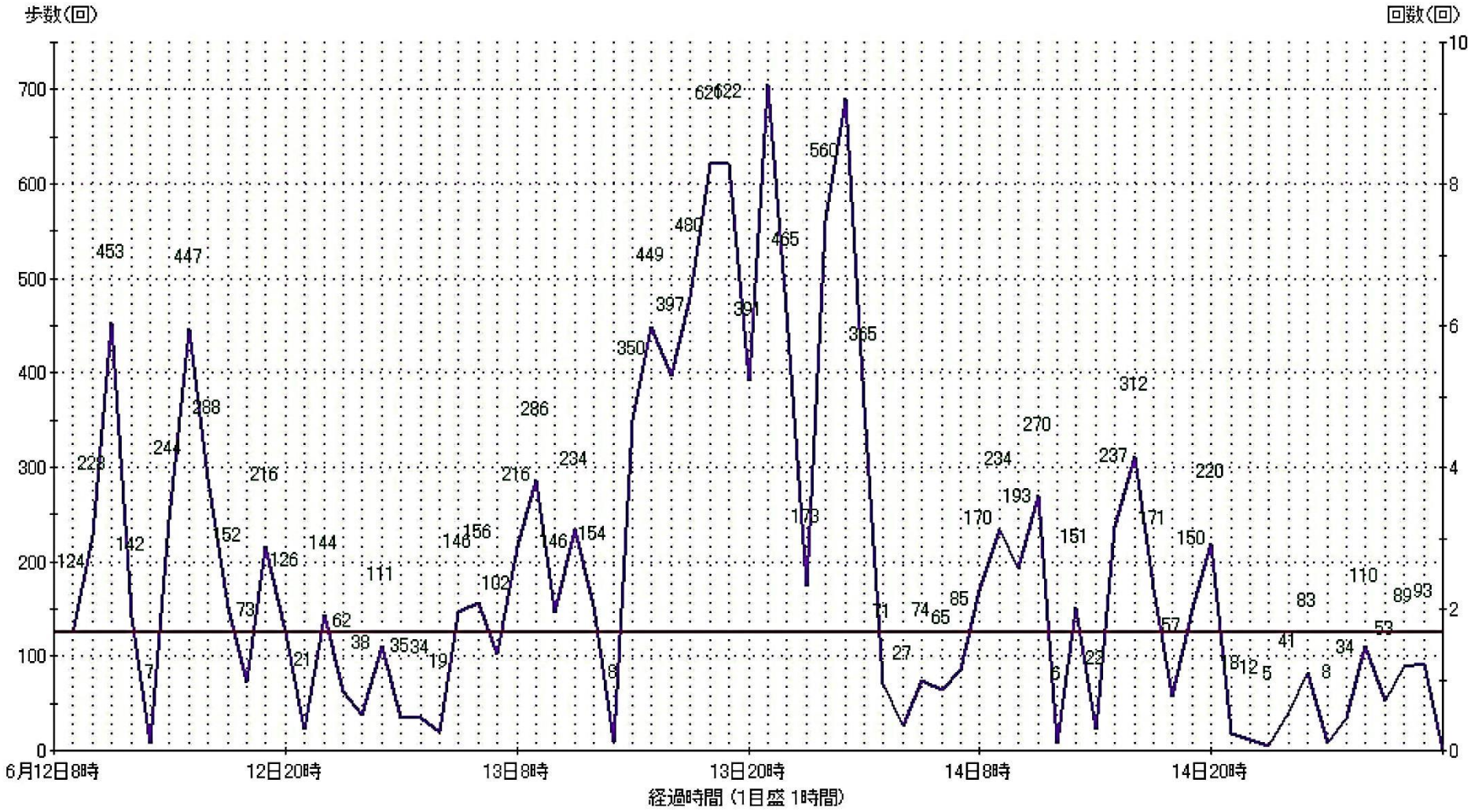
Upgraded device

Antenna and receiver

Messages on a display



Output of activity counts



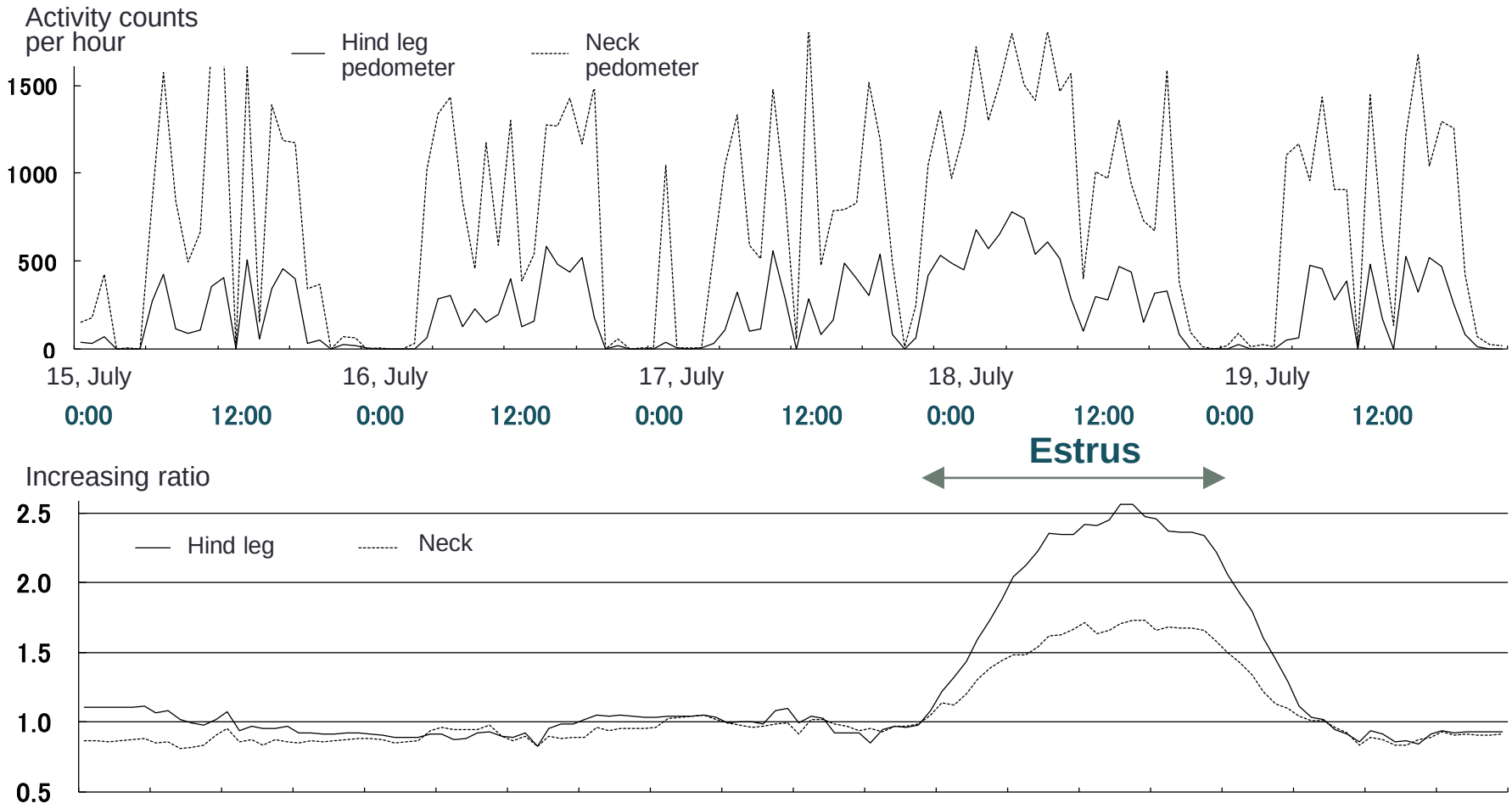
Prototype: mount detector

Back of the fixing pouch

- Hard to maintain the sensor
- Useful only for standing heat
  ⇒ Converted to the **Pedometry system**
- Useful as an experimental tool

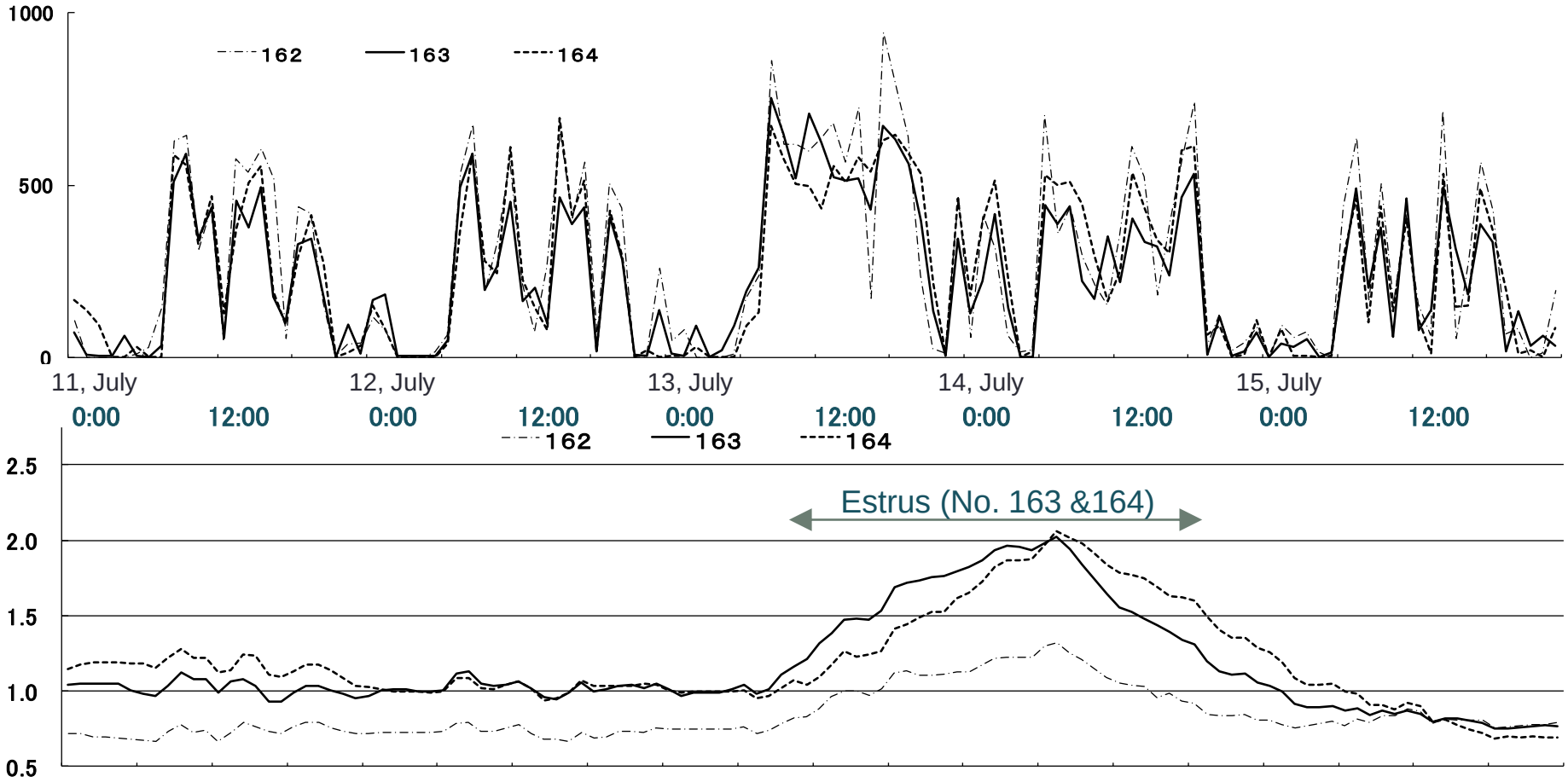
Combined use with tail paint

Changes in activity counts and their increasing ratios of estrous heifers in pasture



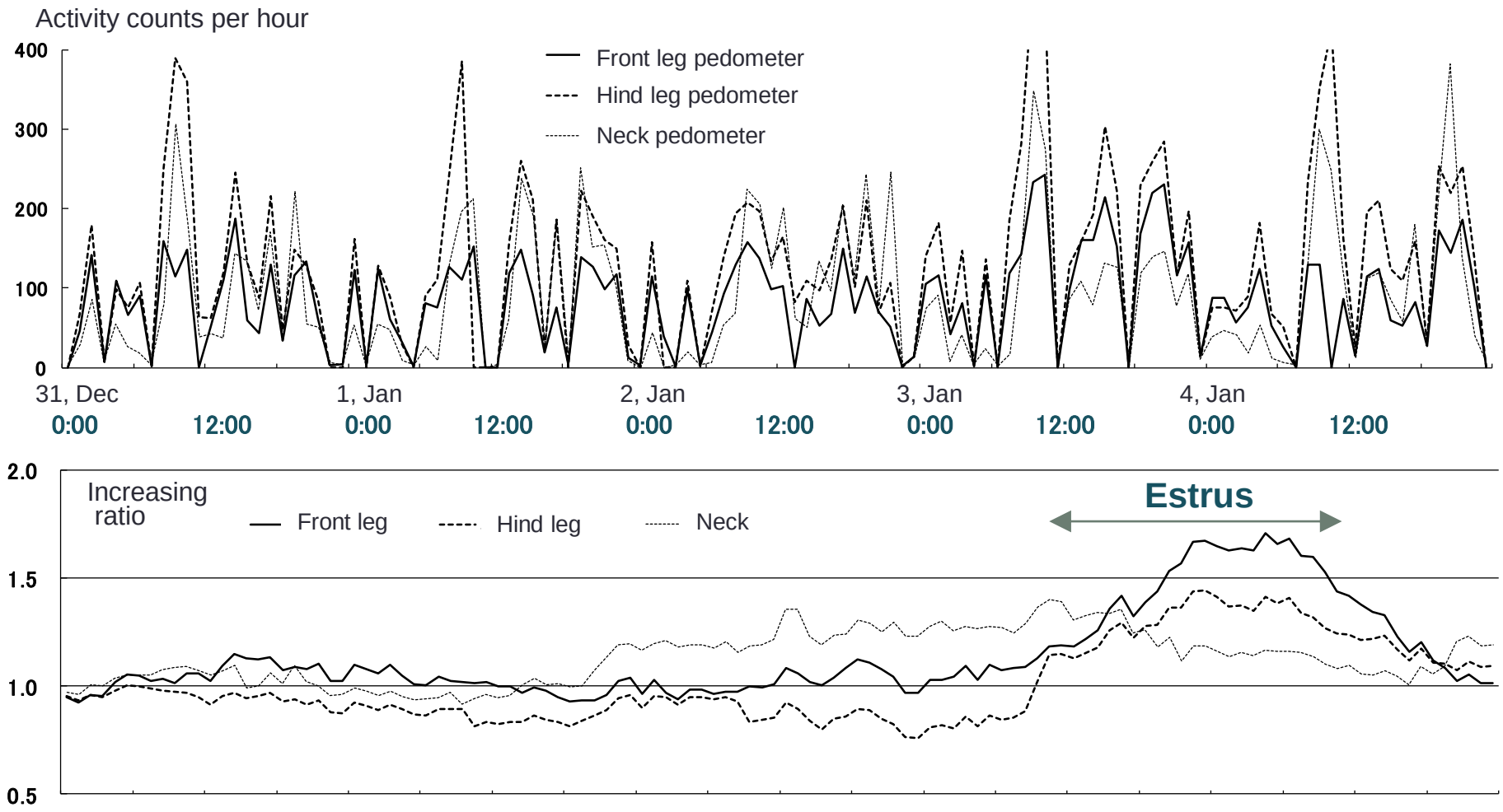
*Reference period: 7 days

Two heifers in estrus with one non-estrual heifer

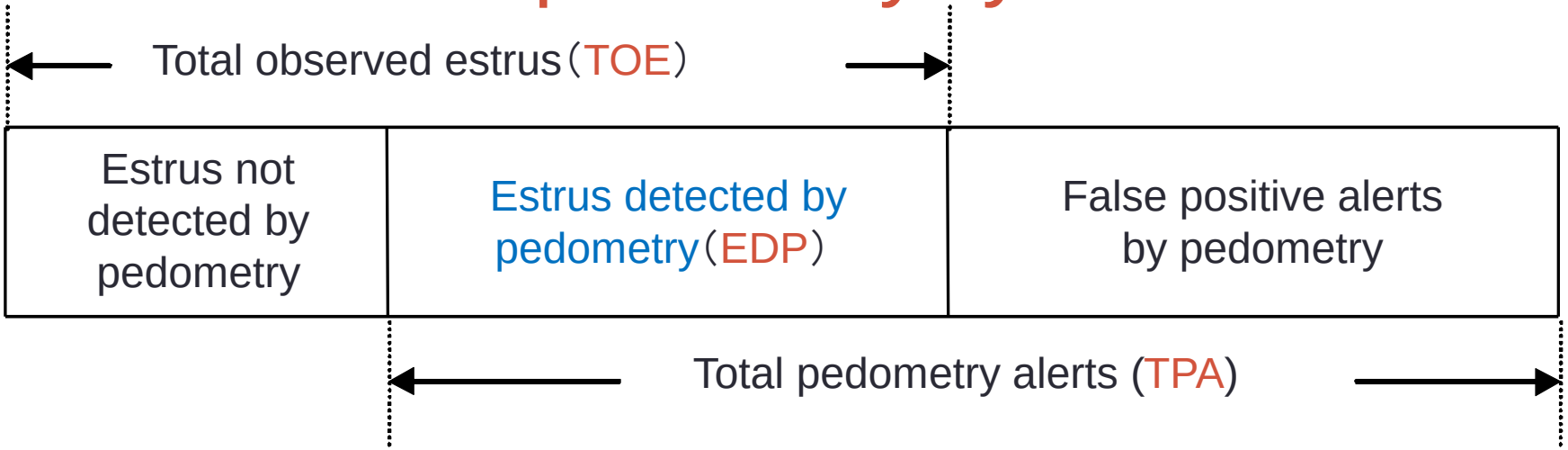


*No. 162 was in estrus during 7 – 8, July (6 days ago)

A heifer in estrus under tie-stall condition



Evaluation of the estrous detection potential of the pedometry system



- ✓Sensitivity = （EDP）/（TOE）× 100（%）
- ✓Specificity = （EDP）/（TPA）× 100（%）
- ✓Detection index = Sensitivity × Specificity / 100

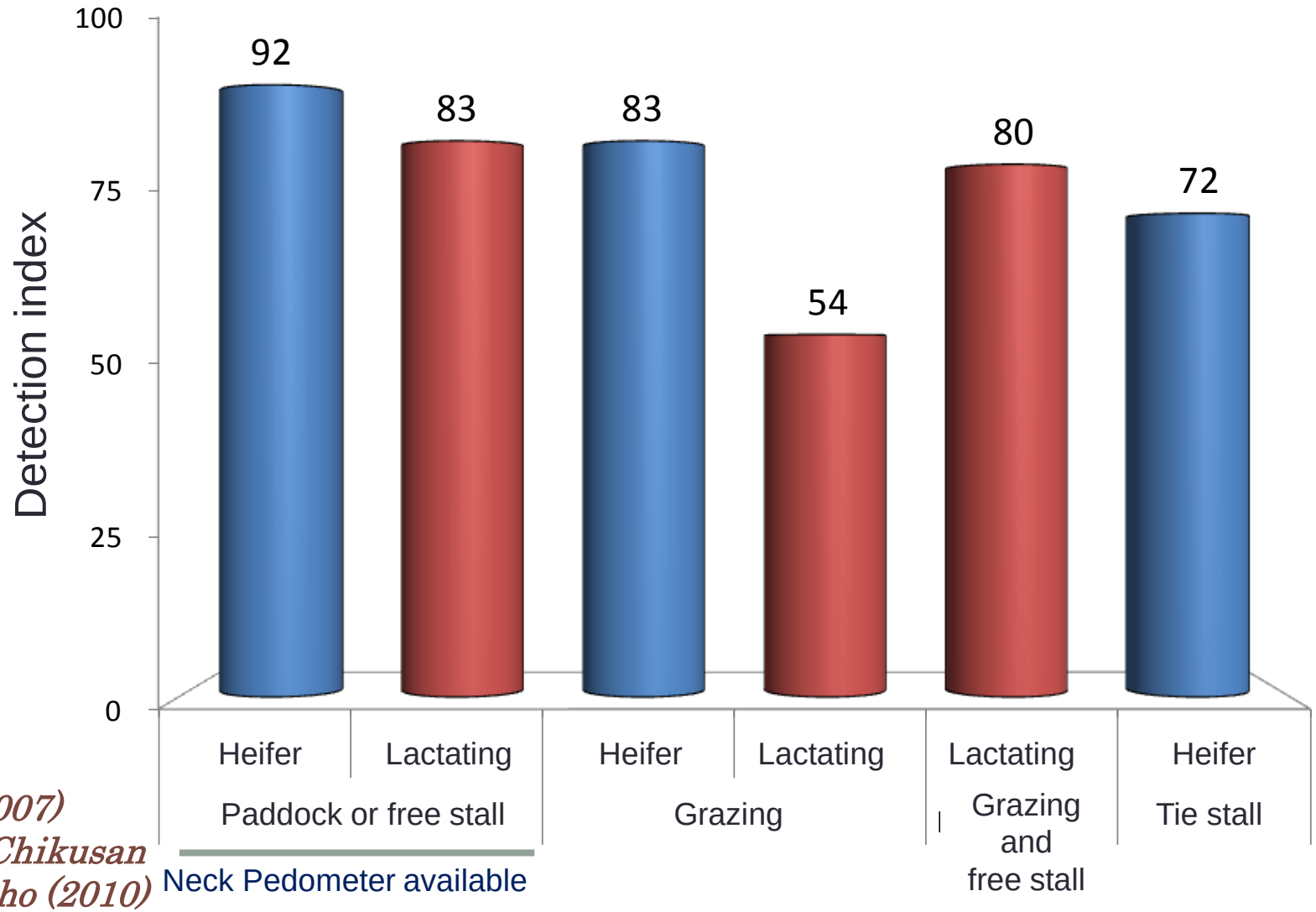
Example Total 10 times of estrus with 8 time detection by pedometry and with 12 times false positive alerts

Sensitivity = 8 / 10 × 100 = 80 %, Specificity = 8 / (8 + 12) × 100 = 40 %

Detection index = 80 × 40 / 100 = 32

JRD (2007)

Comparison of the best detection indices under different conditions

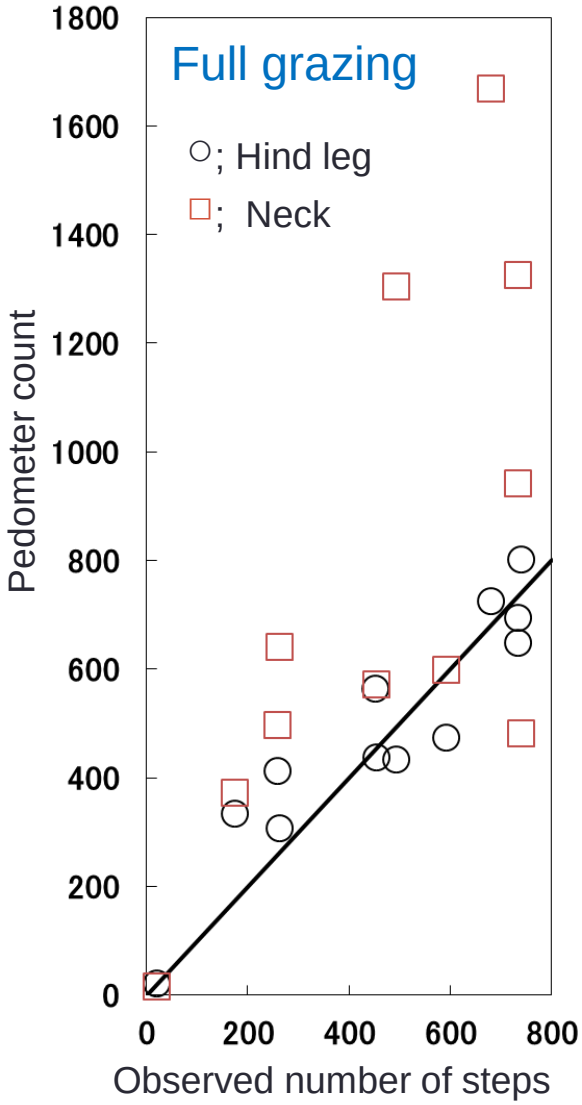


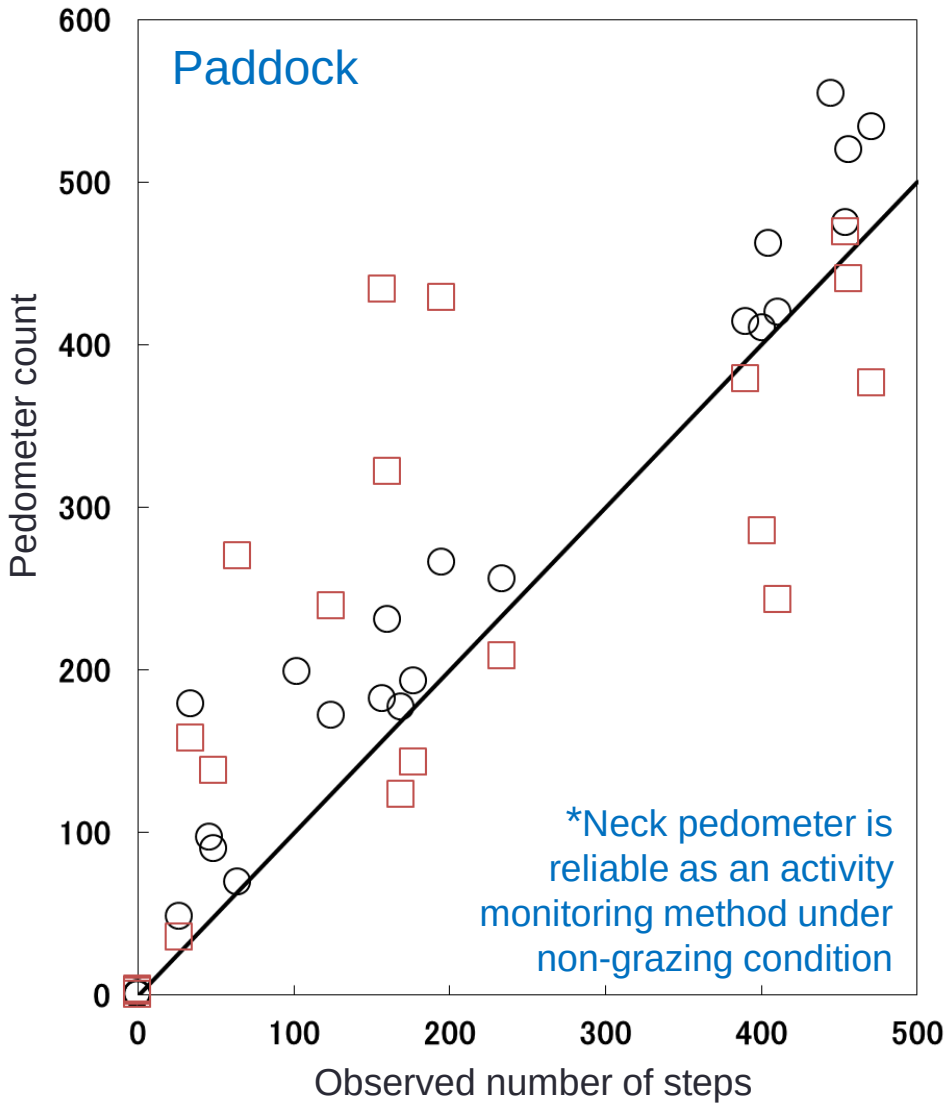
JRD (2007)
Nihon Chikusan Gakkaiho (2010)

Effects of rearing conditions on estrous detection efficiency

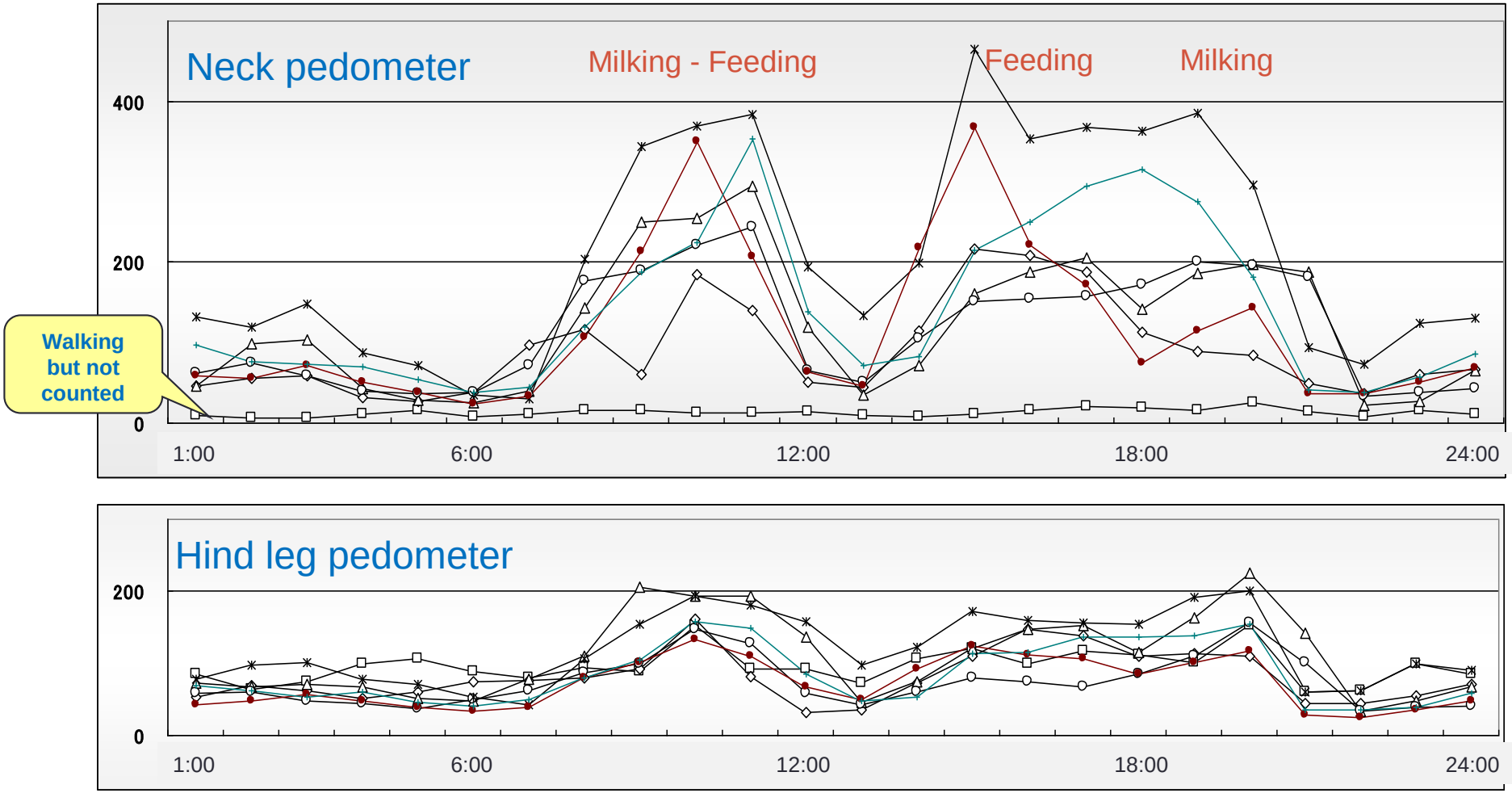
- Paddock / Free stall condition
  - Best detection index in both heifer and lactating cows
  - Neck pedometer is reliable only under this condition
- Full grazing condition
  - Heifer: good detection index
  - Lactating cow: changing pasture affects index (small area pasture)
- Partial grazing condition
  - In large area pasture, almost the same as under free stall condition by leg pedometer
- Tie stall condition (confirmed in heifer only)
  - Slightly lower index but practical level
  - Front leg pedometer > hind leg one

Relationships between observed number of steps and pedometer counts in heifer

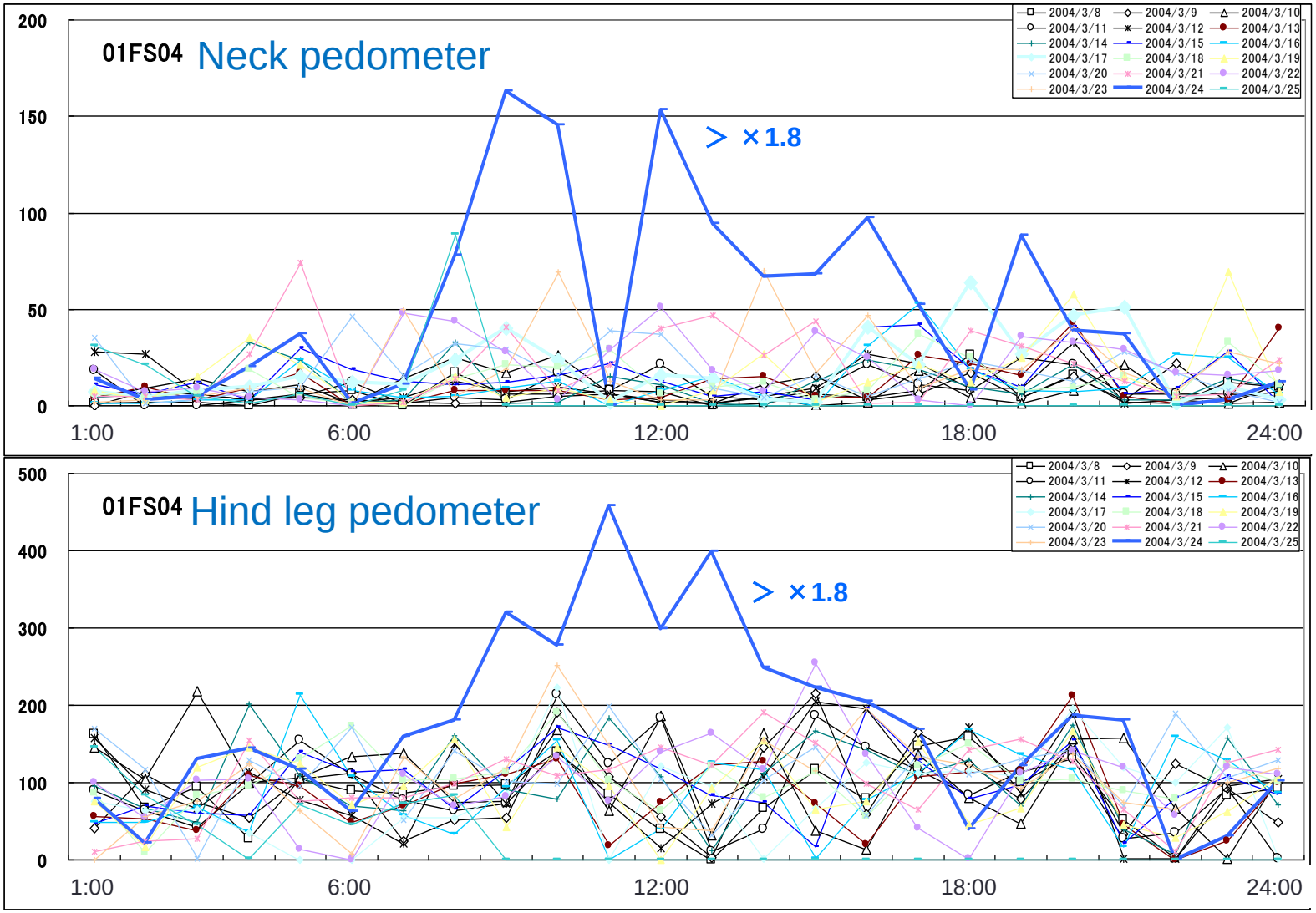




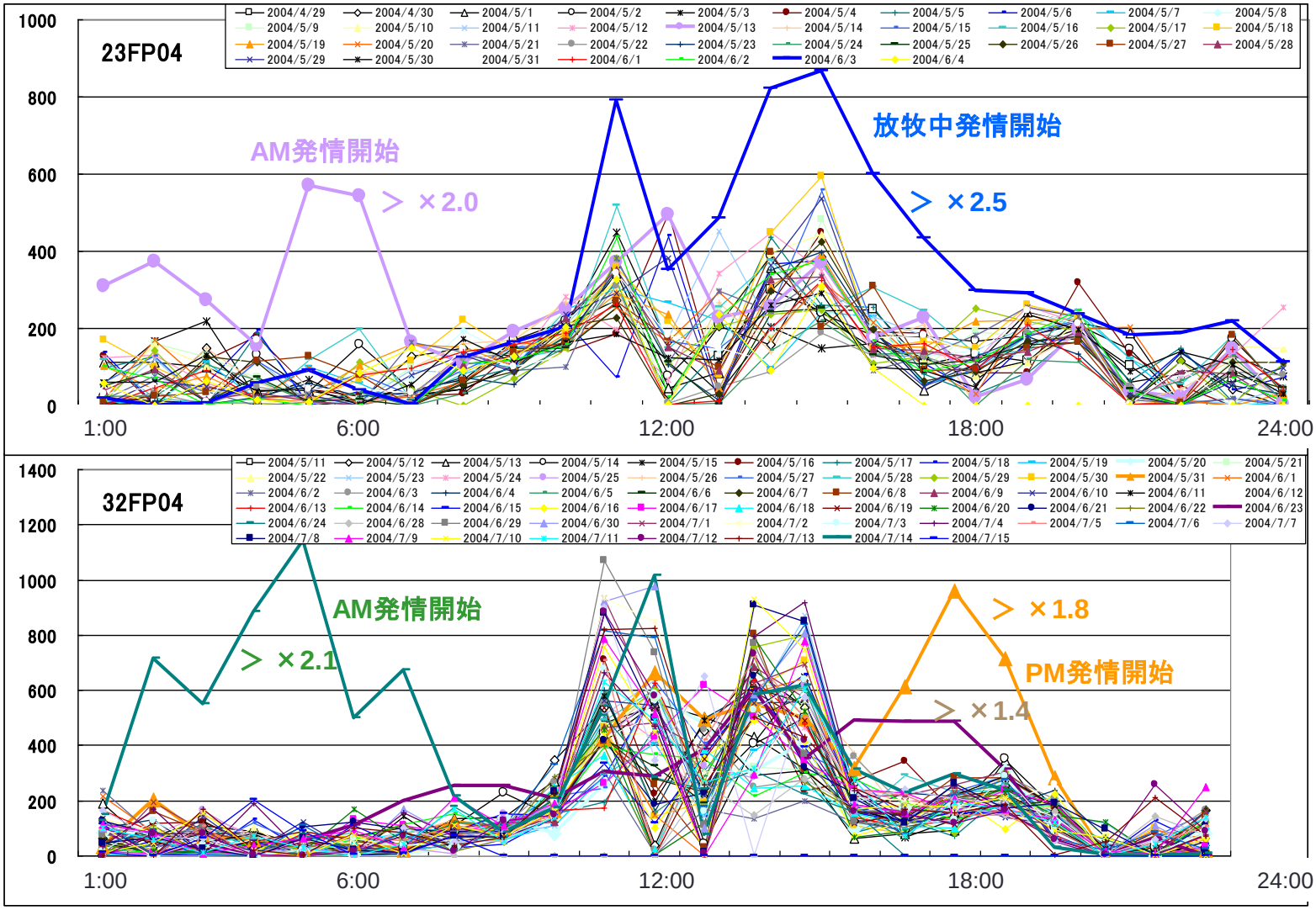
Mean activities during diestrus (7cows, free stall)



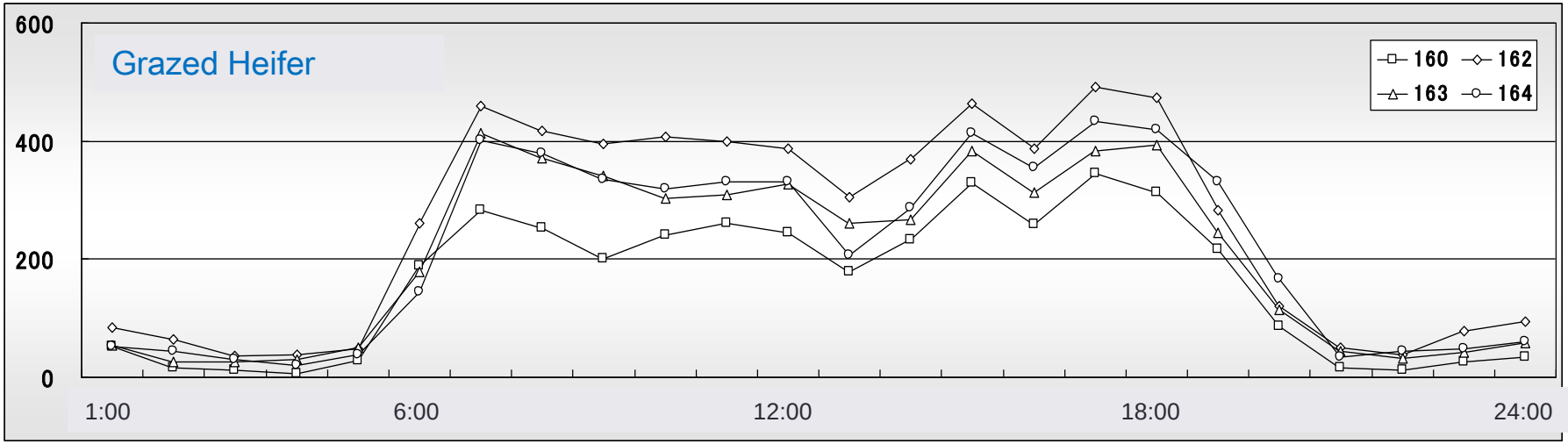
Standing estrus at free stall

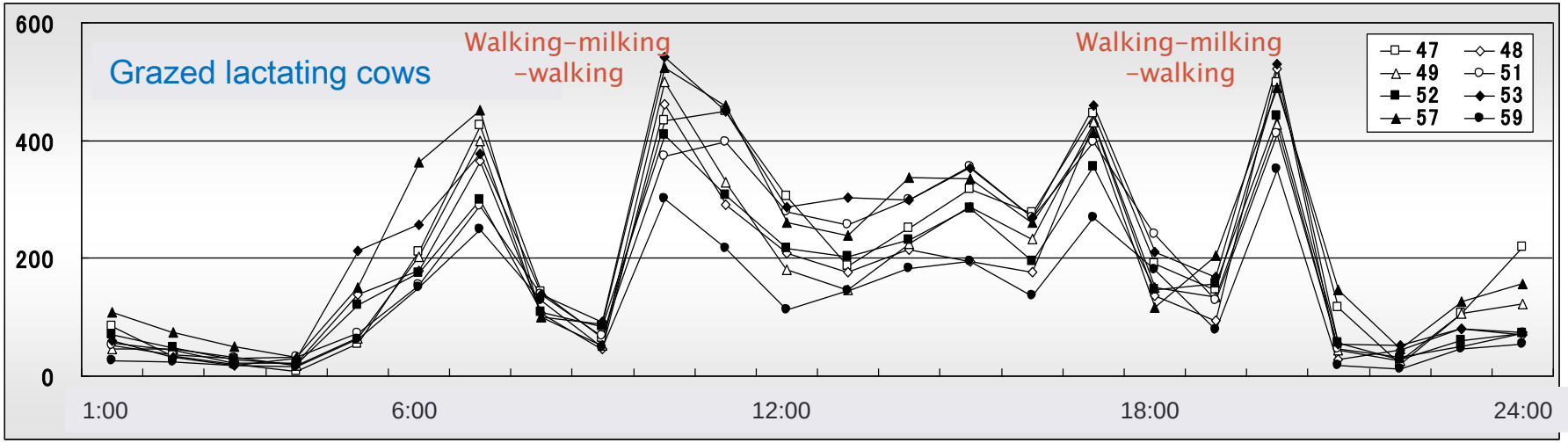


Standing estrus during partial grazing



Walking between milking facility to pasture affects the detection efficiency





*Diestrous periods

Nihon Chikusan Gakkaiho (2010)

Conclusions

- Too early resumption of ovarian activity does not always shorten days open
- Increasing number of cows with no standing heat around the onset of breeding
- Relapsing back into anestrus ovulation after resumption of estrous activity
- Inactive large follicles are harmless（Existence of CLs）
- Milk yield and BW loss (%) can be indices for fertility
- Estrus detection by walking activity is a reliable method（Careful application is needed in milking cows during grazing）

⇒ J Reprod Dev 57(1): 17-33 (2011)

https://www.jstage.jst.go.jp/article/jrd/57/1/57_10-197E/_pdf

5. FUTURE ASPECTS

Economics

Consumers' reactions (animal welfare)

Sustainability

Economics of fertility

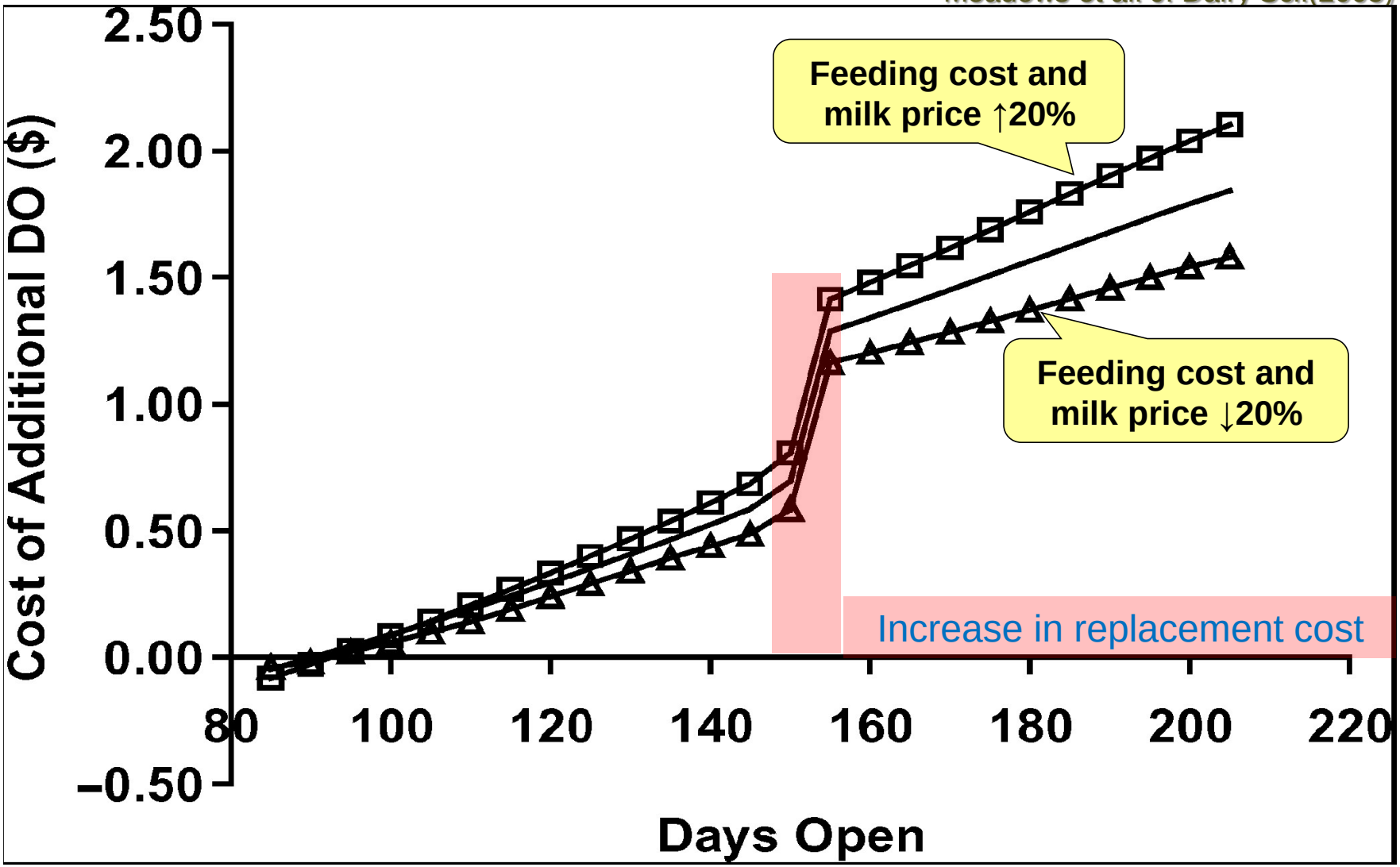
- Increased cost: ¥1,200 per day per cow ?
  Reported at 1993 by Hokkaido NOSAI union

- Effects of management factors, milk yield and lactation curve on economics
  Dry period, feeding cost, milk price, replacement cost….

- Evaluation based on variety of farming types
  management cost , degree of self-sufficiency of feedstuff, grazing or not, heifer rearing……

Reports from Ohio state

Meadows et al. J. Dairy Sci.(2005)



Lactation as a part of reproductive activities

- Mating (estrus) - Pregnancy - **Lactation(suckling)**

＝ Reproductive activities

⇔ Individual growth/maintenance (differed from beef cows)

- Unbalanced nutritional distribution

＝ “Severe mobilization from body reserve to milk”

First priority to lactation

- Heredity: higher in milk yield, lower in reproductive traits

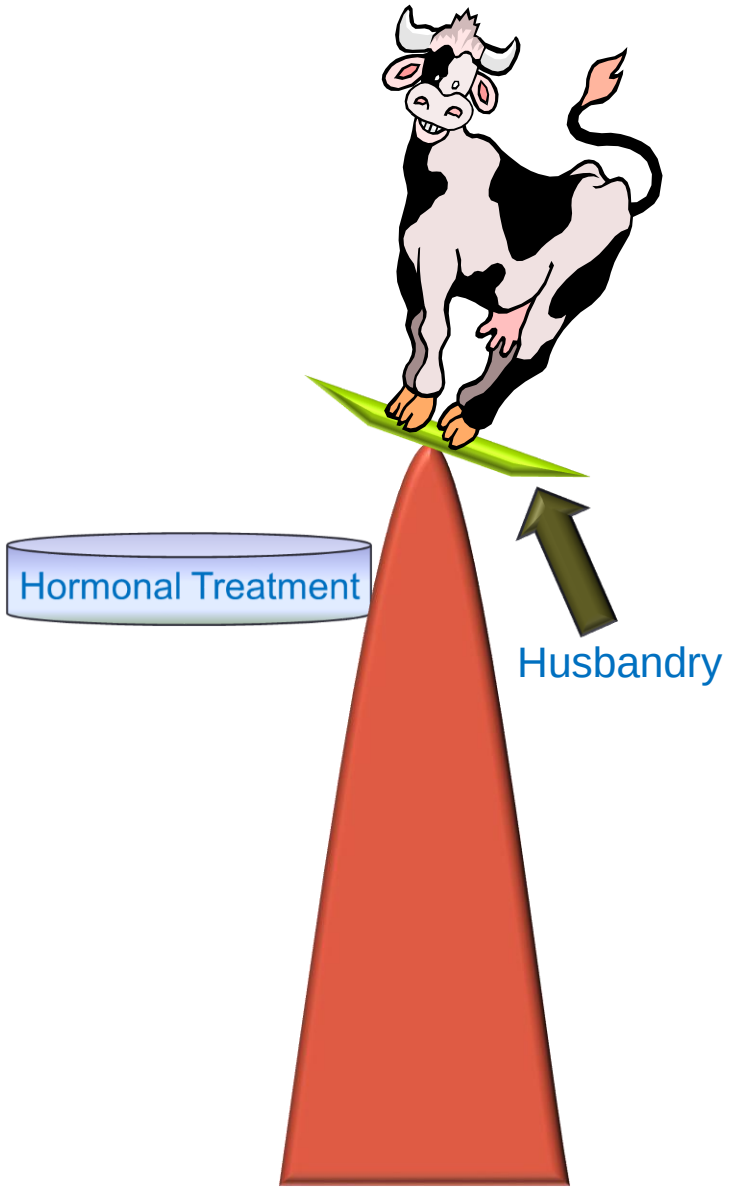
＝ Milk yield somewhat resists management changes

（Persistent production level with declining fertility）

Individual maintenance > Pregnancy maintenance > Lactation > Conception

Is hormonal treatment 'safety net' for fertility problems?

- Hormone preparations are the most effective tools for reproductive disorders ＝「Last resort」
- How effective in healthy cows?
  - Hormonal treatment itself can not improve fertility of cows without plain reproductive disorder
  - Routine use may hide deficiency in management or husbandry
- Proper husbandry is a basis for good fertility
- Consumers have growing interest in food safety and animal welfare



Practical approaches

- Reproductive interventions are effective
  （No management and husbandry problem）
  ＝ Problems only in estrous detection or insemination timing

- More basic problems: nutritional deficiency, diseases, management error
- Persistent employment of hormonal program hide serious problems

- What is the goal of each farm?
  Effective knowledge and techniques

Remarks

- Short-term strategy and long-term strategy
  - Symptomatic treatment (short-term)
  - Lactation as a part of reproductive aactivities
  - ⇒ genetic approach (priority for conception)

- Animal welfare (cow comfort)
  - In relation to food safety
  - Consumers' concerns on antibiotic and hormonal treatment
  - Food animals are not companion animals, but…..
  - Public acceptance

APPENDIX: TWIN PREGNANCY

Multiple ovulation caused by high milk production

Japanese Shorthorn (JSH)

Transfer of in vitro-produced Japanese Black (JB) embryos to bred recipients

Purpose: More beef calves per dam

Frequent stillbirth

Different pregnancy periods between JSH and JB affected?

In creased frequency of twin parturition in high-producing dairy cattle

- In beef cattle, twinning can produced more calves

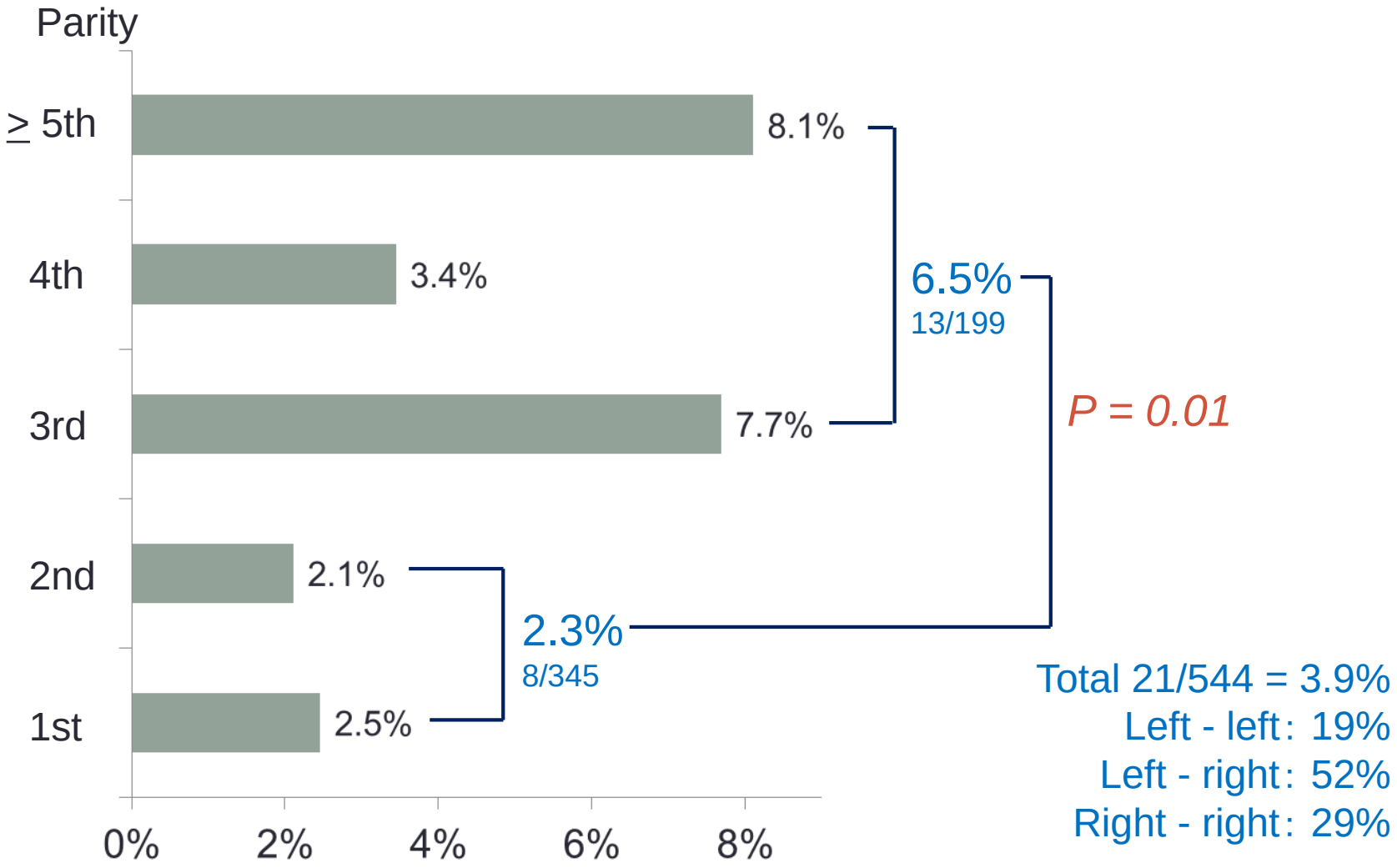
- In dairy cattle, almost harmful for productivity
  - Direct cause: twin (multiple) ovulation
  - High milk yield ⇒ feed intake↑ ⇒ portal vein blood flow↑ ⇒ steriod metabolism↑(blood E_2↓) ⇒ multiple follicular growth
  - Semen never causes twinning
  - Undernutrition induces twinning?

    High-production often causes undernutrition?

  - Diagnosis: ultrasonography during early pregnancy period (- D80)

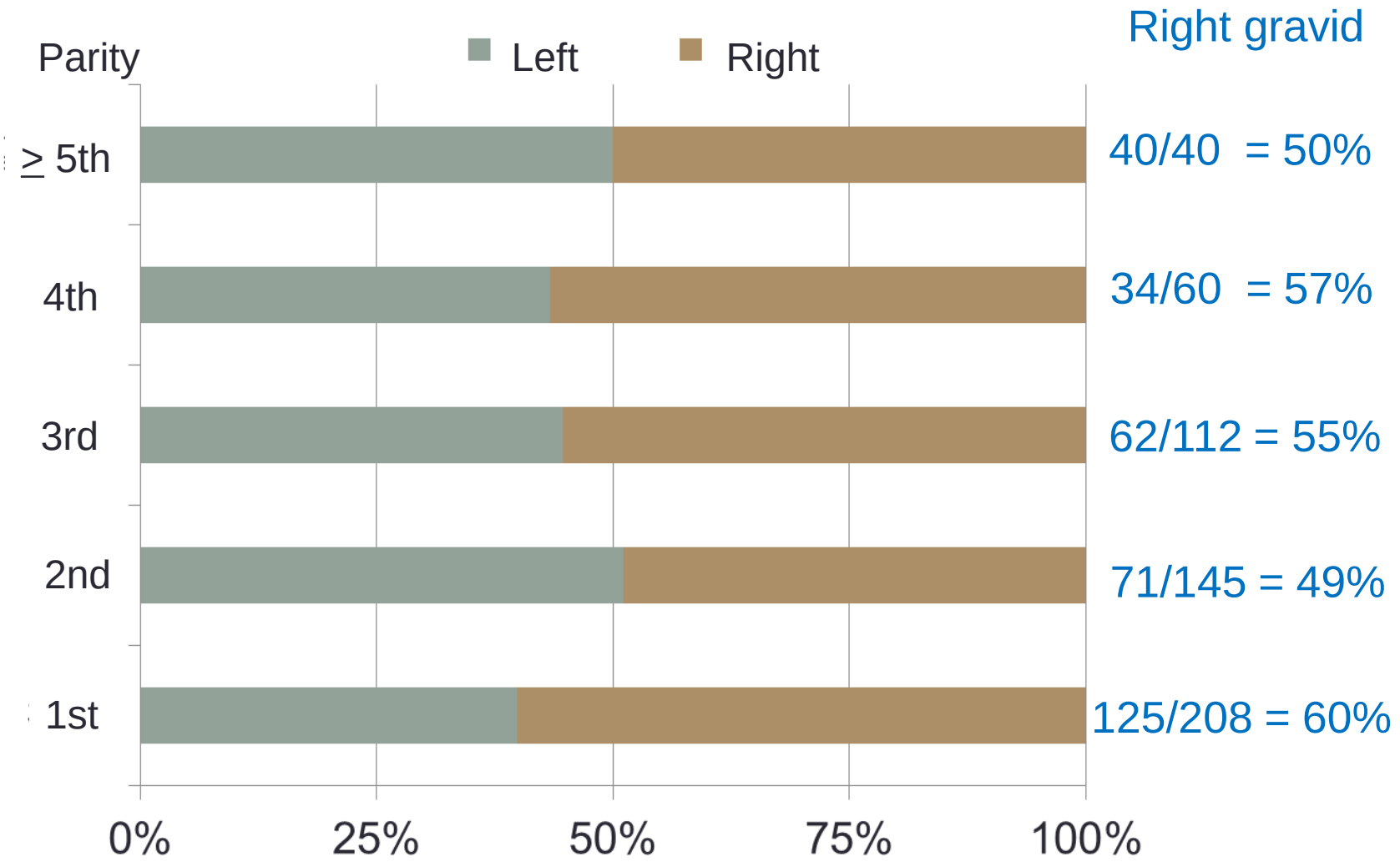
    Low abortion occurrence after this perid

Occurrence of twin birth

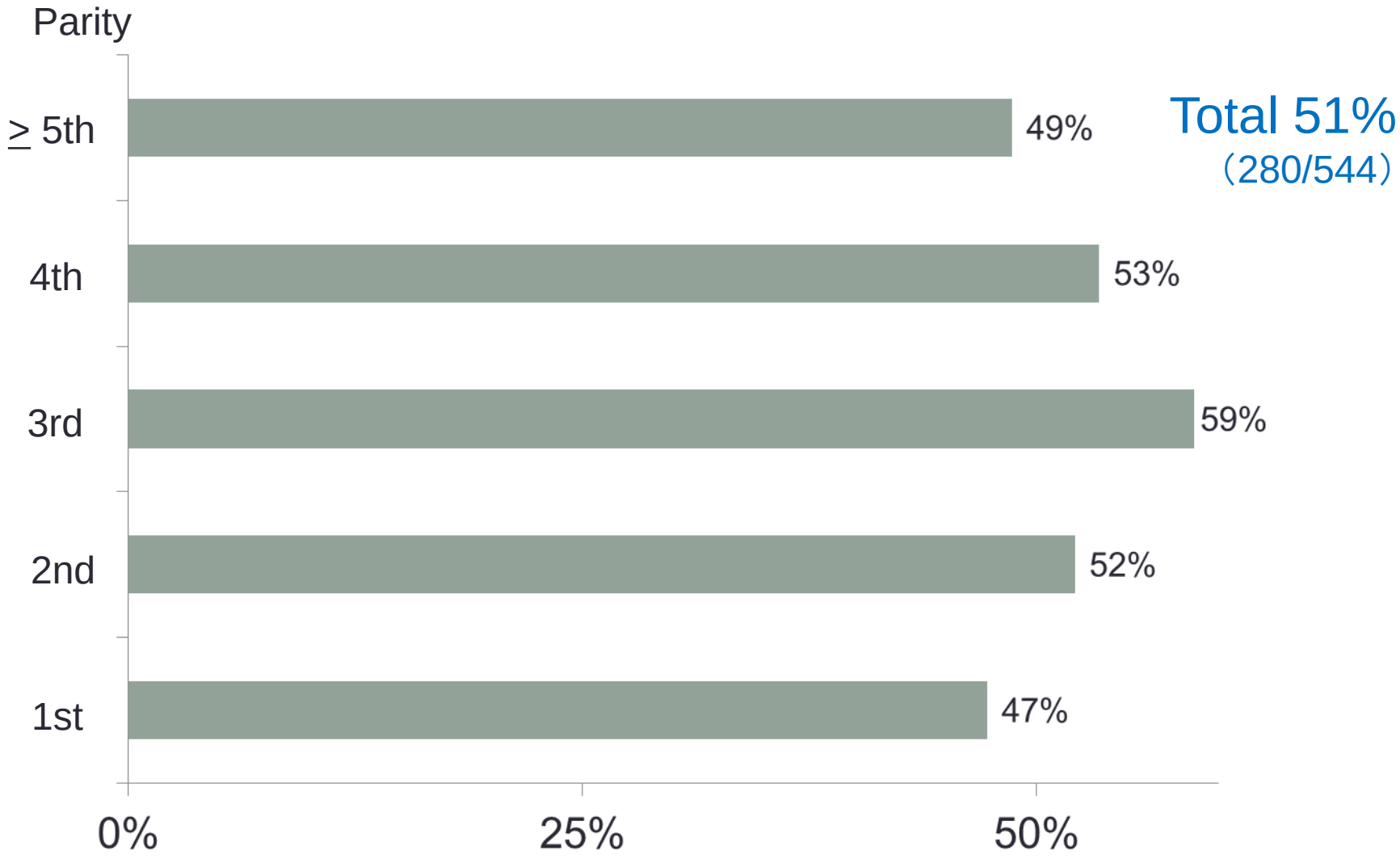


Total 21/544 = 3.9%
Left - left: 19%
Left - right: 52%
Right - right: 29%

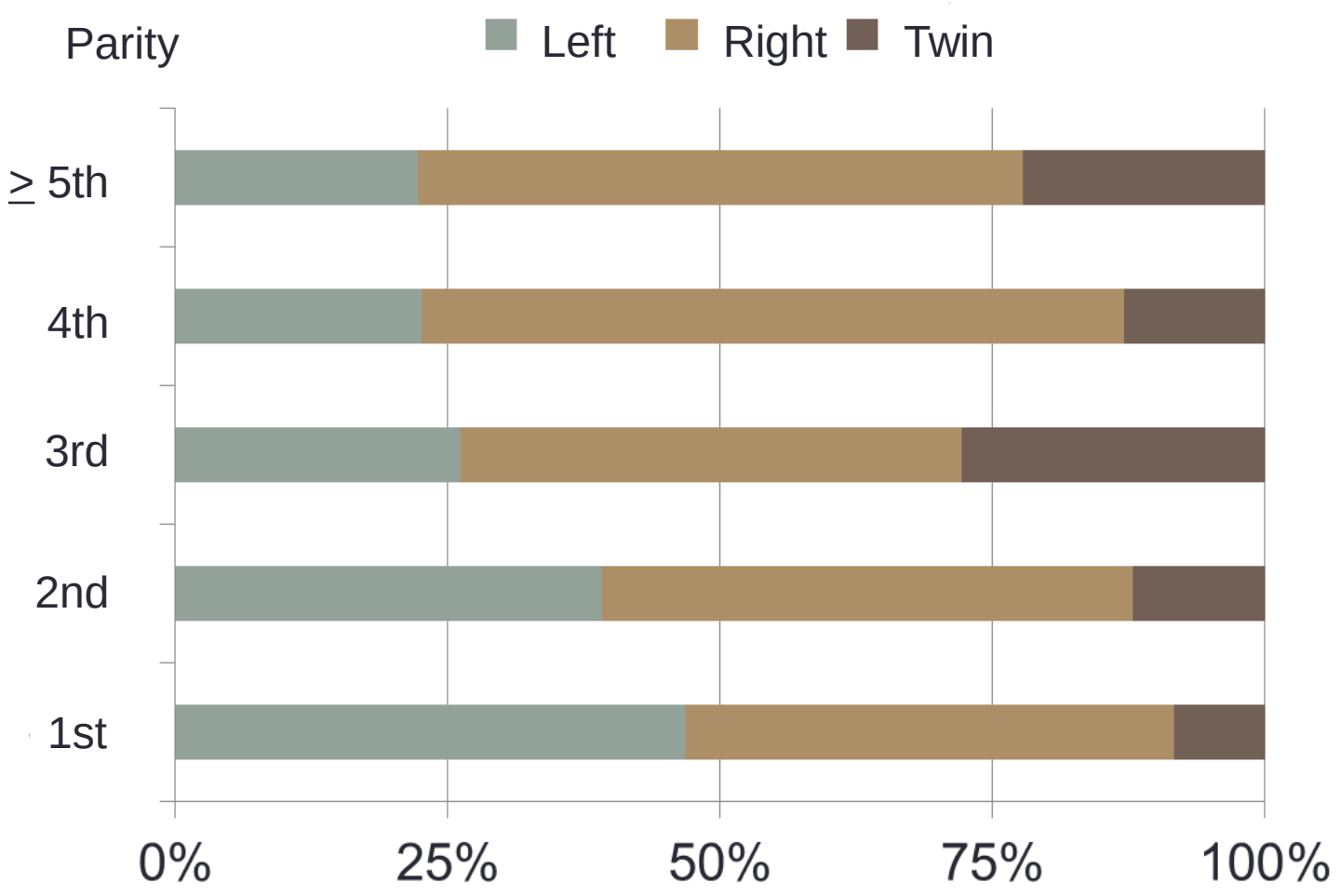
Side of gravid horn (including twins)



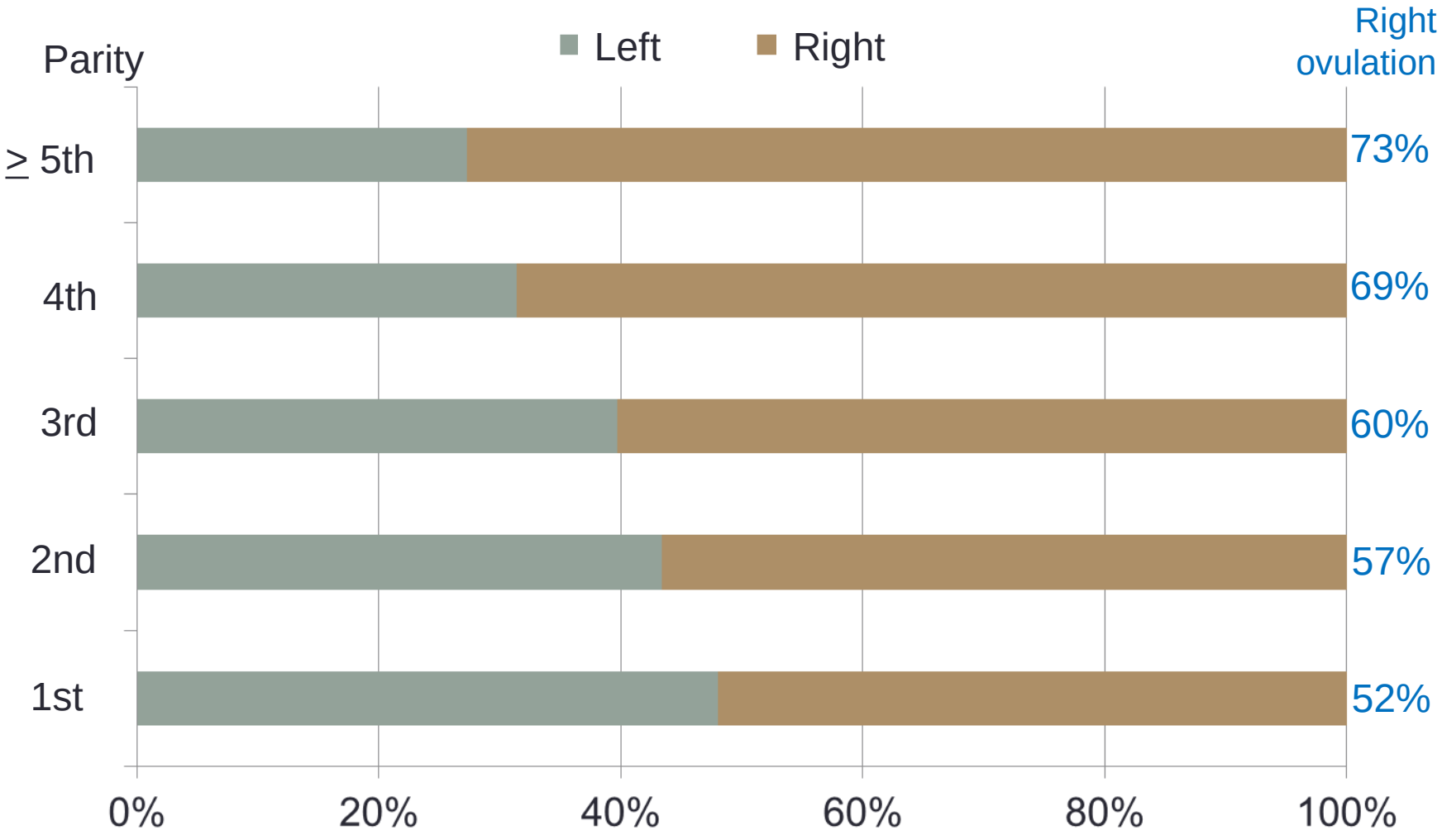
Ovulation within 3 weeks postpartum



Single ovulation side and twin ovulation



Ovulation side including twin

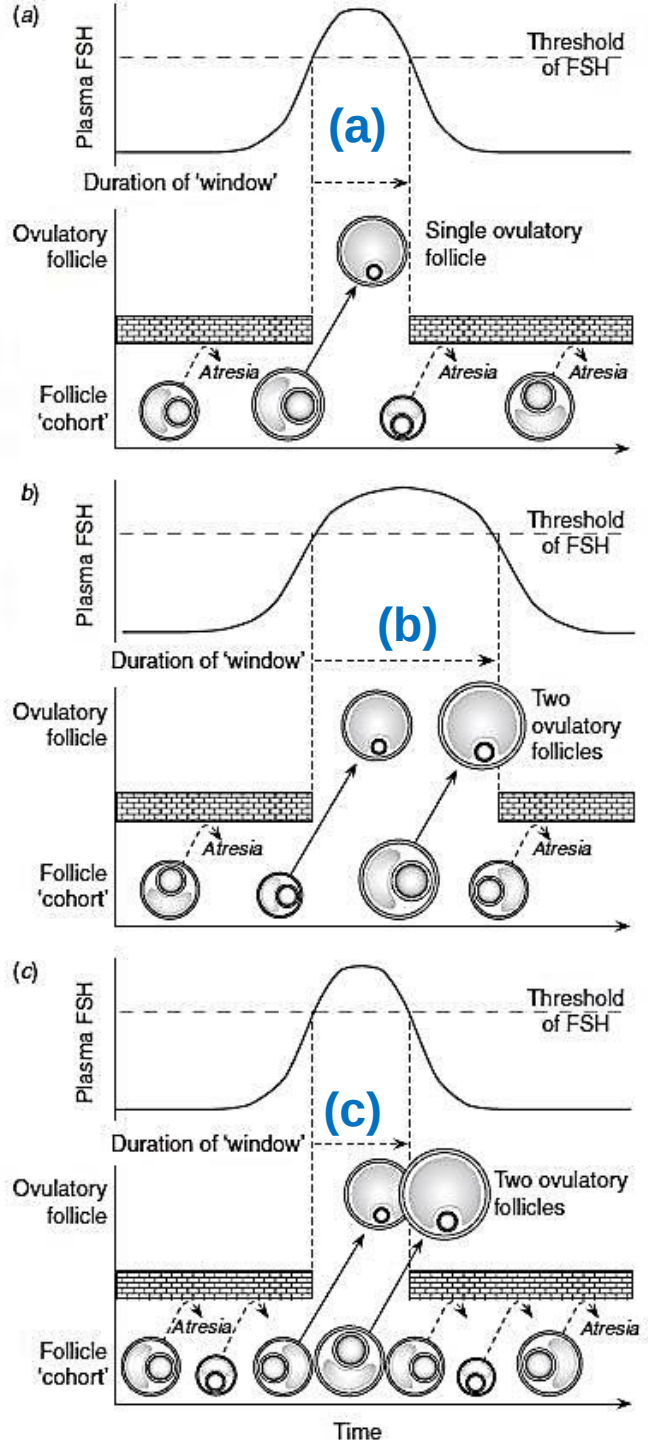


Twinning rate, gravid horn, ovulation side

- Twinning rate
  - First to 2nd parity; about 2 % ⇒ ≥ 3rd; >6%
    = After 2nd parturition, twin ovulation and implantation increase ?
- Gravid horn
  - Right side may be more frequent with some parity effects
- Early postpartum ovulation
  - Most frequently at 3rd parity
  - Increased twin ovulation > 3rd parity
  - Higher parity higher right side ovulation ratio

Ovulation rate control

Fig. 5. A model of the interactions that control ovulation rate. To become ovulatory, members of a cohort of gonadotrophin-dependent follicles need their stage of development to coincide with a selection window, the width of which is determined by the period of time that FSH concentrations exceed the critical threshold needed to prevent atresia (*a*). Ovulation rate can be increased by increasing the width of the window (*b*) or by increasing the number of gonadotrophin-dependent follicles that are ready to pass through the window (*c*).



Hypothesis for twin ovulation

Higher production ⇒ E_2 metabolism(liver)↑

⇒ Negative feedback to FSH secretion↓


0025
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2
2