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飼育下のホッキョクグマがペーシングによって消費するエネルギー量の解明

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（受付：2024 年 5 月 10 日，受理：2024 年 7 月 8 日）

Energy expenditure of captive polar bear exhibiting pacing behavior

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摘　要

飼育下の動物で特異的に観察される常同行動は，動物が低福祉状態にある時に多く発現することが報告されている。そのため，常同行動に関する多くの研究は，その発現を抑止することや発現頻度を減少させることに着目してきた。しかし，常同行動の発現が動物に与える影響を考慮せず単にこれを抑制する行為は，動物福祉をさらに低下させる可能性があるかもしれない。従って，まずは常同行動の発現による動物への影響を明らかにし，その影響に基づいて常同行動への対応を検討する必要があると考えられる。そこで本研究では，常同行動の一種であるペーシングを対象に，その発現が動物の身体へ与える影響を評価・検討することを目的とし，ペーシングによって消費されるエネルギー量の定量化を試みた。

調査期間は 2023 年 5 月から 10 月とし，毎月 9 日間，9 時 5 分から 16 時 25 分までの間，北海道帯広市のおびひろ動物園において，展示されているメスのホッキョクグマ 1 頭の観察を行った。観察によって明らかとなったペーシングによる歩行距離に基づき消費エネルギーの定量化を行った結果，ペーシングによって消費されたエネルギー量は数百 kcal ／日程度であった。ヒトやイヌの先行研究との比較により，ペーシングの発現が意義のある運動としてホッキョクグマに影響を与えている可能性が示唆された。この結果は，これまで行われてきたペーシングへの対処に一石を投じるものであり，今後様々な視点からペーシングを含めた常同行動への対応を議論することが重要であろう。

キーワード：動物福祉，常同行動，運動，*Ursus maritimus*

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緒　論

動物園で飼育されている動物には，野生下で見られない常同行動がしばしば観察される。常同行動とは，“繰り返し行われ，様式が不変であり，明確な目的や機能がない行動パターン”のことである（Mason 1991）。常同行動には，例えば，アジアゾウ *Elephas maximus* の熊癖（Wilson et al. 2004），キリン *Giraffa camelopardalis* やオカピ *Okapia johnstoni* の柵なめ（Bashaw et al. 2001），トラ *Panthera tigris*（Mohapatra et al. 2014）やヒョウ *Panthera pardus*（Mallapur and Chellam 2002）等の食肉類でよく見られるペーシング（常同歩行）等（Clubb and Mason 2003），様々なものがある。

常同行動は多くの場合，動物が低福祉状態にある時に観察されることが分かっているため（Mason and Latham 2004），常同行動についての多くの研究が，常同行動を抑止させることやその発現頻度を低減させることに着目している（Clubb and Vickery 2006）。しかし，常同行動が動物にとって何らかの意味を持ち役立つものであった場合，その発現を単に抑制することは動物にさらなる悪影響を及ぼす可能性がある（Ödberg 2006）。例えば，アカゲザル *Macaca mulatta* が行う自傷行動の割合は，ストレス指標と負の相関を持つことがわかっており（Novak et al. 2006），この行動を物理的に抑制することは，福祉の低下を招くことにもなるため，安易に実施すべきではないことが示唆されている（Appleby et al. 2017）。このように，常同行動への対処を検討する際には，その行動が発現することによる影響を十分理解する必要があると考えることができる。

そこで本研究では，飼育下において頻繁に観察される常同行動をテーマとして，その行動による影響に関する検討を行い，常同行動への対応をどのように捉えるべきかを考察する．高頻度で観察される常同行動として，検知が困難な獣舎内で発現するものではなく，展示飼育場での観察が比較的容易なペーシングを選択し，そして，食肉類の中でもペーシングの発現頻度が比較的高いことが報告されているホッキョクグマ *Ursus maritimus*（Clubb and Mason 2003）を研究対象とした。ペーシングは，飼育場内において同一の経路を往来する行動と定義されている（Breton and Barrot 2014）ことから，これを発現させることによって，エネルギー消費への寄与を考えることができるかもしれない。実際に，繋留されているブタ *Sus scrofa domesticus* では，常同行動を発現している個体が，発現していない個体よりも多くのエネルギーを消費した例が報告されている（Cronin et al. 1986）。運動は様々な疾病のリスクを低下させ（Warburton et al. 2006），肥満を防止する上でも重要な要素である（Laflamme 2006）。そのため，動物園という非常に限られた環境下で生活する動物園動物にとって，ペーシングが重要な運動として機能しているならば，安易な抑制が長期的にみると動物福祉を低下させる可能性が考えられる。そこで本研究では，ペーシングが動物へ与える身体的な影響を検討するための基礎的知見の提供，及びその検討を目的とし，飼育下のホッキョクグマがペーシングによって消費するエネルギー量の定量化を試みた。

方　法

調査地及び調査個体

調査地は，北海道帯広市のおびひろ動物園内（9 時開園，16 時 30 分閉園）のホッキョクグマ舎（図 1）とした．調査個体は，おびひろ動物園で飼育されている 12 歳（2023 年 4 月時点）でメスのホッキョクグマ 1 頭（愛称:アイラ）とした（図 2）。

予備調査

本調査での調査時間を検討するため，ホッキョクグマがペーシングを行う時間帯を調査した。調査期間は，2023 年の 4 月 29 日～ 30 日，5 月 2 日～ 4 日，5 月 9 日～ 10 日の 7 日間，9 時 5 分から 16 時 20 分までの間（4 月 30 日のみ 9 時 30 分から開始）とし，調査は個体追跡サンプリングにより行った。

図 1. 本研究で観察を行ったおびひろ動物園のホッキョクグマ舎.

A: 全体の写真, B: 左側部分の写真,
C: 右側部分の写真.

A.

B.

C.

図 2. 本研究で観察対象としたメスのホッキョクグマ（*Ursus maritimus*）個体.

本調査

調査期間は 2023 年の 5 月から 10 月とし，月に 9 日間調査を行うこととした。10 月の調査では月内に 9 日間の調査を実施することができなかったため，10 月中に 7 日間，11 月の初めに 2 日間(11 月 1 日,2 日)の調査を行い，これを 10 月分のデータとして扱った。観察時間は 9 時 5 分から 16 時 25 分までとした。ペーシングの観察は基本的に目視によって直接行ったが，これと並行して補助的にハンディーカメラ（SONY HDR-CX680）を用いた撮影を行った。なおカメラによる撮影については,カメラのバッテリーの容量の問題等により，上記の観察時間帯を全てカバーできないことがあった。また，9 月 25 日以降は，ホッキョクグマ舎周囲の改装工事により目視観察を行うことができなかったため，ハンディーカメラによる記録のみを用いて観察を行った。

ペーシングは，Bernstein-Kurtycz et al. (2022), Cless et al. (2015) を参考に，中断することなく同じ経路を 3 回往来した場合とした。ペーシング開始後に歩行経路の歩行回数を記録した。経路途中で歩行を中断した場合，ペーシングを終了したとみなし，それまでに往来が完了していたペーシングを歩行回数として記録した。ホッキョクグマ舎内において，ペーシングに利用された歩行経路の長さをメジャーを用いて計測した。

消費エネルギーの定量化

ペーシングによる消費エネルギーは，Hand et al. (2014) を参考に以下の式 1 を用いて日単位で定量化した。

式 1： 消費エネルギー（kcal）= BW［(1.77d × $BW^{-0.4}$) + (1.25 × $BW^{-0.25}$)］

D：歩行距離（km），BW：体重（kg）

なお，ペーシングによる歩行距離 d は，本調査で記録したペーシングの歩行回数，および計測した歩行経路の長さから算出した。また，体重は推定値 200kg を利用した（おびひろ動物園提供）。

基礎代謝量の算出

ホッキョクグマの基礎代謝量は，Kleiber（1947）を参考に以下の式２で求めた。

式２：基礎代謝量（kcal）= 70(kcal/kg) × $BW^{0.75}$(kg)

BW：体重（kg）

消費されたエネルギーが占める割合の算出

式１で算出されたペーシングによる１日の消費エネルギーが，１日の摂取エネルギーの内，活動によって消費あるいは体内に蓄積されるエネルギーに対して，どの程度の割合を占めるのかを以下の式３を用いて算出した。

式３：

$$\frac{\text{ペーシングによる消費エネルギー（kcal）}}{\text{1日に摂取した総エネルギー量(kcal)-基礎代謝量（kcal）}}$$

ホッキョクグマが１日に摂取する給餌内容の記録は，おびひろ動物園から提供された．また，動物園のデータにエネルギー表示がない餌に関しては，文部科学省の日本食品標準成分表 2020 年版（https://www.mext.go.jp/a_menu/syokuhinseibun/mext_01110.html）を参考とした。また，野菜や果物等の中で，個数単位や袋単位で給餌されている餌についてはエネルギー計算から除外した。

統計解析

ホッキョクグマは生活史に応じて移動パターンに変化が認められることが知られている（Amstrup et al. 2000; Demaster and Stirling 1981）。飼育下においても歩行距離に差異が生じ，ペーシングによって消費されるエネルギー量に季節変化が見られるかどうかを判断するため統計解析を行った。得られたデータは，調査期間の６ヶ月間を春（５月，６月），夏（７月，８月），秋（９月，10 月）の３群に分け，クラスカル・ウォリス検定を用いて比較した。３群に有意差が見られた場合には，２群ごとにマンホイットニーの U 検定を行い，ボンフェローニ法を用いて補正した。

結　果

予備調査

ホッキョクグマがペーシングを行う時間帯は，日によって違いが見られ，途中でペーシングが発現しない時間帯があったものの，最大で９時５分から 16 時 20 分までであった（図 3）。この時間帯をカバーするために，本調査は９時５分から 16 時 25 分まで行うこととした。

図 3. 予備調査で観察されたホッキョクグマ（*Ursus maritimus*）のペーシングの発現時間帯.
灰色：発現あり，白色：発現なし，
黒色：データなし.

	4月29日	4月30日	5月2日	5月3日	5月4日	5月9日	5月10日
9 : 05							
9 : 25							
9 : 45							
10 : 05							
10 : 25							
10 : 45							
11 : 05							
11 : 25							
11 : 45							
12 : 05							
12 : 25							
12 : 45							
13 : 05							
13 : 25							
13 : 45							
14 : 05							
14 : 25							
14 : 45							
15 : 05							
15 : 25							
15 : 45							
16 : 05-16 : 20							

本調査

５月から 10 月までのペーシングの観察から，繁用される歩行経路が 10 通り検出され，これらを歩行距離の算出に用いた（図 4）。これらの経路に基づいて算出した歩行距離，および摂取カロリーと消費カロリーを表１に示した。各月の歩行距離の平均値は，５月が 9.04 km，６月が 5.96 km，７月が 3.19 km，８月が 2.91 km，９月が 3.21 km，10 月が 5.46 km であり，消費カロリーの平均値は，５月が 450.67 kcal，６月が 319.71 kcal，７月が 201.94 kcal，８月が 190.00 kcal，９月が 202.85 kcal，10 月が 298.46 kcal であった（表 2）．また，ホッキョクグマの基礎代謝量は 3,722.81 kcal であり，以上のデータから計算したホッキョクグマが活動によって消費するあるいは体内に蓄積されると考えられるエネルギーの内，ペー

シングによって消費されたエネルギーが占める割合を表1に示した。それらの月別の平均値は，5月が6.1%，6月が5.0%，7月が2.7%，8月が3.4%，9月が3.6%，10月が5.3%であった（表3）。

また，クラスカル・ウォリス検定の結果，春（5月，6月），夏（7月，8月），秋（9月，10月）の3群で有意差が見られた（$P < 0.05$）。マンホイットニーの U 検定およびボンフェローニ法による補正によって2群ごとの比較を行った結果，春と夏および春と秋の間で有意差が確認されたが（$P < 0.05$），夏と秋の間では確認されなかった（$P > 0.05$）。

図4. ホッキョクグマ（*Ursus maritimus*）のペーシングに繁用された10通りの経路とその長さ（煩雑な表示を避けるため，A～Dの図に分けて記した）．同色の線が持つ双方向の矢印が，それぞれのペーシング経路の始点と終点を表す．

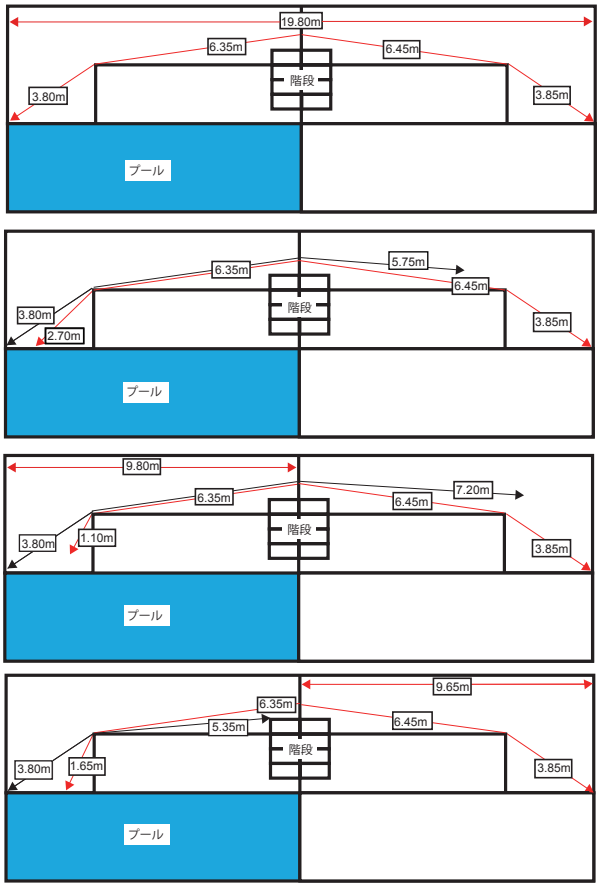


表1. 飼育下ホッキョクグマ（*Ursus maritimus*）の観察日ごとの摂取カロリーおよびペーシングによる歩行距離と消費カロリー．
＊ペーシングによるエネルギー消費が，活動によって消費，または蓄積されるエネルギーに占める割合．

月 日	摂取カロリー (kcal)	歩行距離 (km)	消費カロリー (kcal)	*割合(%)
5月22日	10452.75	5.30	291.69	4.3
23日	11214.40	10.74	523.28	7.0
24日	11988.40	7.26	375.16	4.5
25日	10453.71	7.95	404.52	6.0
27日	11227.55	12.52	598.63	8.0
28日	11371.39	6.30	334.29	4.4
29日	11923.85	6.50	342.85	4.2
30日	11371.39	13.62	645.59	8.4
31日	10233.71	11.14	540.03	8.3
6月17日	11678.06	9.12	454.33	5.7
18日	10990.80	5.28	290.82	4.0
19日	10578.06	6.29	333.93	4.9
20日	9542.85	9.28	461.06	7.9
21日	9749.70	4.01	236.91	3.9
22日	11126.69	0.29	78.95	1.1
26日	10660.80	4.73	267.39	3.9
27日	9129.15	4.75	268.28	5.0
28日	9129.15	9.86	485.71	9.0
7月19日	9542.85	3.18	201.53	3.5
20日	11340.77	3.93	233.56	3.1
24日	11760.80	3.71	224.28	2.8
25日	11974.93	4.83	272.06	3.3
26日	11792.30	4.27	247.86	3.1
27日	10990.80	3.62	220.39	3.0
29日	10660.80	0.97	107.90	1.6
30日	10970.12	2.72	182.11	2.5
31日	10241.44	1.44	127.77	2.0
8月21日	10213.56	3.89	231.99	3.6
22日	8669.94	2.48	171.79	3.5
23日	8669.94	3.41	211.31	4.3
25日	9356.94	3.27	205.60	3.6
26日	8478.44	2.97	192.56	4.0
27日	8669.94	2.16	158.19	3.2
29日	9439.94	1.76	141.49	2.5
30日	9814.94	3.00	194.13	3.2
31日	11102.94	3.21	202.99	2.8
9月21日	8949.96	1.52	131.32	2.5
22日	10561.96	3.23	203.86	3.0
23日	8527.96	4.71	266.68	5.5
25日	9088.46	2.77	184.34	3.4
26日	8729.96	3.83	229.40	4.6
27日	11076.96	4.73	267.80	3.6
28日	8949.96	2.62	178.00	3.4
29日	8953.96	3.50	215.17	4.1
30日	10893.58	1.94	149.04	2.1
10月17日	10842.96	7.09	367.79	5.2
22日	8868.46	5.97	320.30	6.2
23日	9499.96	3.17	201.14	3.5
24日	9820.36	6.61	347.34	5.7
29日	8953.96	5.21	287.93	5.5
30日	10150.49	5.46	298.84	4.6
31日	8538.46	6.12	326.55	6.8
11月1日	8729.96	4.53	259.27	5.2
2日	8953.96	4.95	276.95	5.3

表 2. 飼育下ホッキョクグマ（*Ursus maritimus*）のペーシングに伴う歩行距離と消費カロリーの月別平均値

月	歩行距離（km）	消費カロリー（kcal）
5月	9.04 ± 3.01	450.67 ± 128.17
6月	5.96 ± 3.08	319.71 ± 130.81
7月	3.19 ± 1.28	201.94 ± 54.32
8月	2.91 ± 0.66	190.00 ± 28.17
9月	3.21 ± 1.12	202.85 ± 47.60
10月	5.46 ± 1.18	298.46 ± 50.05

表 3. 飼育下ホッキョクグマ（*Ursus maritimus*）のペーシングによるエネルギー消費が，活動によって消費，または体内に蓄積されるエネルギーに占める月別平均割合

月	割合（%）
5月	6.1 ± 1.8
6月	5.0 ± 2.3
7月	2.7 ± 0.6
8月	3.4 ± 0.6
9月	3.6 ± 1.1
10月	5.3 ± 0.9

考　察

本研究の結果，飼育下のホッキョクグマにおいてペーシングによって消費されるエネルギー量は，1 日で数百 kcal 程度であり（表 1），これは本種の活動によって消費される，或いは体内に蓄積されると考えられるエネルギー量の内，数%程度（表 1）を占めるものであることが明らかになった。従ってペーシングにより生理学的に大きな負担は生じておらず，ペーシングは運動としての意義をもつ可能性があることが示唆された。

クマ類において，どの程度のエネルギー消費であれば運動として有意義であるのかはこれまでに報告されていない。しかしながら，今回の結果をヒトおよびクマ類と同じ食肉類であるイヌ *Canis lupus familiaris* の先行研究と比較することで，ペーシングの運動としての意義を検討することにする。ヒトを対象とした研究例では，1 週間に 1,000 kcal 程度の運動を行うことにより，死亡リスクが 20%から 30%程度低下することが示唆されている（Lee and Skerrett 2001）。また，イヌにおいて推奨されている運動量は，週に 5 ～ 7 回の頻度でおよそ 15 分～ 30 分歩く程度のものであり（Hand et al. 2014），さらに週に 1 回，1 時間程度の運動で肥満のリスクが低減されることも報告されている（Robertson 2002）。厚生労働省が示している日本人のカロリーの摂取基準（https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/kenkou_iryou/kenkou/eiyou/syokuji_kijyun.html）によると，通常 18 歳から 29 歳のヒトの 1 日あたりの推定エネルギー必要量は 2,650kcal で，基礎代謝量は 1,530kcal である。推定エネルギー必要量を摂取カロリーと仮定して計算すると，Lee and Skerrett（2001）によって示唆された 1 週間当たり 1,000 kcal の運動は，1 日あたりの活動によって消費あるいは蓄積されると考えられるエネルギー量の内，12.8 %程度である（計算式は以下のとおりである）。

$$\frac{\text{運動による1日の消費エネルギー(kcal)}}{\text{1日に摂取した総エネルギー(kcal)-基礎代謝量(kcal)}} = \frac{1{,}000/7}{2{,}650\text{-}1{,}350}$$

また，同様にイヌにおいて，Finke（1994）を参考に，体重 6 kg のイヌの 1 日の摂取エネルギーを 490 kcal とし，このイヌが 4 km/h の速さで 30 分間歩行したと仮定すると，消費されるエネルギーは以下の式の通り 15 kcal 程度と算出される。

式 1 ＝ $6\,[(1.77 \times 2 \times 6^{-0.4}) + (1.25 \times 6^{-0.25})]$

1 日 30 分程度の歩行を週 7 回行ったとしても，消費エネルギーが占める割合は以下の計算式から 6.8%程度である。

$$\frac{\text{運動による1日の消費エネルギー(kcal)}}{\text{1日に摂取した総エネルギー(kcal)-基礎代謝量(kcal)}} = \frac{15}{490 - 268}$$

これらのことから，健康や肥満の防止等を目的とした

運動の場合，活動によって消費あるいは体内に蓄積されるエネルギー量の内，数%程度を消費すれば十分であると考えることができる。動物園動物は，ヒトや愛玩動物と比べるとエネルギー代謝に関する知見が少なく，給餌内容の細かな調整等が難しい場合があるかもしれない。このため，適度な運動は健康を維持するために重要な意味を持つ可能性があるかもしれない。以上のことから，ホッキョクグマが行うペーシングは，運動としての意義をもつ可能性が示唆され，その発現に対しては様々な対処方法が考えられる。例えば，ペーシングの抑制を試みる際には，単にその頻度や所要時間を減少させるのではなく，ペーシングの代替となる運動（行動）を促すような工夫が重要であるかもしれない。また，抑制のみを検討するのではなく，ペーシングに適した経路を構築するなど，これを利用した飼育方法の確立も考えられるかもしれない。これについては今後の検討課題であろう。

本研究の結果からペーシングによって消費されるエネルギー量は，季節によって変化する傾向が示唆された。ペーシングに影響を与えると考えられる要因は様々であるため［例えば，来園者密度（Kelly et al. 2015），気温（岡 ほか 2019），給餌方法（Fernandez 2021）等］，本研究で見られた季節変化の要因を特定することは難しい。そのため，断片的な議論になるが，ペーシングに季節変化が見られた要因の一つとして，ホッキョクグマが自然下で行う行動を背景としたものが考えられるかもしれない。アメリカクロクマ *Ursus americanus* を対象とした研究では，ペーシングの季節変化が自然下で行われる繁殖および採餌の欲求に左右されることが示唆されている（Carlstead and Seidensticker 1991）。ホッキョクグマの繁殖期は3月から6月であり（Demaster and Stirling 1981），本研究においてペーシングによる消費エネルギーが比較的多かった時期と一致する(図5,図6)。また，ホッキョクグマは7月下旬から3ヶ月～5ヶ月間は海氷上ではなく陸上で過ごし（Russell 1975），この時期はほとんど絶食することが知られている（Robbins et al. 2012; Atkinson and Ramsay 1995）。本研究で消費エネルギーが比較的少なかった時期はこの期間とほぼ一致する結果となった（図5, 図6）。さらに，野生のホッキョクグマは11月中旬から海氷上でアザラシを捕食するため移動を開始する（Lunn 1985）。本研究では11月以降の観察は行っていないが，9月まで少なかった消費エネルギーが10月において急増する傾向を観察することができた（図5）。以上の結果から，今回見られたペーシングの季節変化は，野生下で見られる本種のフェノロジーに影響を受けた結果である可能性が考えられるかもしれない。しかしながら，既述の通り，ペーシングに影響を与える要因は様々であり，また野生下での生活を経験していない（学習をしていない）ホッキョクグマ個体にフェノロジーに関連する行動が明瞭に発現するかについては不明である。従って，今回観察されたエネルギー消費の季節変化が，フェノロジーのみに影響されたものであると結論付けることは難しく，これについても今後の検討課題であろう。

図5. 飼育下ホッキョクグマ（*Ursus maritimus*）の1日の消費エネルギーの月ごとの変化.

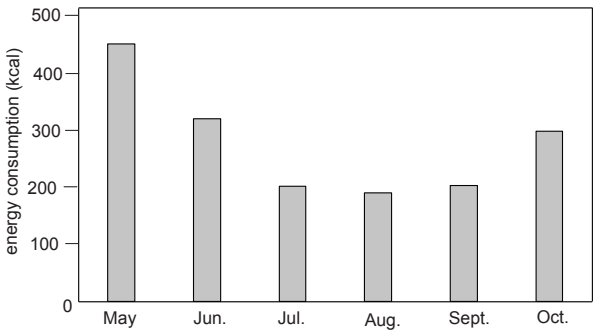
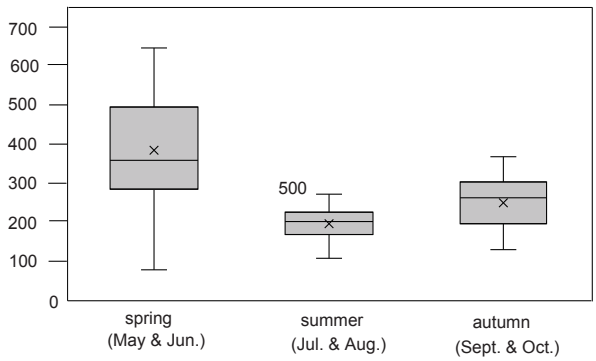


図6. 飼育下ホッキョクグマ（*Ursus maritimus*）の1日の消費エネルギーの季節ごとの比較



本研究の結果は，動物園動物の動物福祉をさらに向上させるための議論の足掛かりとなるものである。前述の通り，常同行動は多くの場合，動物が低福祉状態にある時に観察され（Mason and Latham 2004），欲求不満や，ストレス，恐怖や刺激の不足などと関連していることが示唆されている（Mason 1991）。しかし，ペーシングが運動としての意義を持つ可能性が示唆された今回の結果は，これまでの常同行動への対応に一石を投じるものであり，より議論を深化さるためにも今後様々な視点から常同行動を検討することが肝要であろう。

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Energy expenditure of captive polar bear exhibiting pacing behavior

Stereotypic behaviors are particularly observed in captive mammals when they are in poor welfare. Therefore, numerical studies on stereotypical behaviors have focused on suppressing or reducing their frequency. However, merely inhibiting these stereotypic behaviors without considering their impact on animals may exacerbate concerns regarding animal welfare well-being. In this study, we aimed to evaluate the effects of 'pacing', which is a typical stereotypic behavior of stressed large mammals, on the body of large mammal and to quantify the amount of energy consumed by such pacing. We observed a female polar bear at the Obihiro Zoo in Obihiro, Hokkaido, Japan, nine days a month from May to October 2023, from 9:05 a.m. to 4:25 p.m. We quantified the energy consumption based on the distance walked by pacing and found that the daily energy consumption from pacing was several hundred kcal. Compared with published researches on humans and dogs, our finding suggests that the expression of pacing may be a meaningful exercise. This may offer novel insights into addressing pacing behavior. It will be important to explore strategies for managing stereotypic behavior, including pacing, from various diverse perspectives in future discussion.

Res. Bull. Obihiro Univ. 45：11 ～ 17（2024）

インドネシアにおける中小規模酪農経営の実態について

森岡昌子 *・毛利泰大 **

（受付：2024 年 4 月 30 日，受理：2024 年 7 月 8 日）

An Overview of Small and Medium-Scale Dairy Farming Practices in Indonesia

Masako MORIOKA*, Yasuhiro MORI**

摘　要

後発開発途上国を中心とした人口増加と経済成長によって，肉や乳製品といったたんぱく源の需要が急速に伸びている。新興国の中でも唯一，2000 年代以降も経済成長を続けているインドネシアも例外ではない。その一方で，熱帯地域における酪農経営の実態に関する知見は非常に限られており，今後も伸びると予想される需要や飼料確保に生産現場がどのように対応しているのか不明である。そこで現地調査を通じて，経営の概要を整理した。結果として，10 年前と比較して乳量がほぼ同水準であること，粗飼料と濃厚飼料の両方で飼料確保に課題があることが明らかとなった。

キーワード：インドネシア，熱帯酪農，小規模経営，東ジャワ，SPP14

はじめに

世界の食料需要の変化は，長期的には人口増加と各国の経済成長が要因である。いわゆる新興国やそれに次ぐ国々を中心に，著しい人口増加と経済成長を経験してきた。それに伴い，栄養と嗜好性を満たす肉や乳製品といった畜産物への需要が高まってきている。それに対応するように後発開発途上国の畜産物生産も増加してきた。一部の国では生産が停滞傾向にあり，需要に追いついていない。そのような状況の中，インドネシアは，新興国の

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中でも 2000 年代以降も経済成長を続けており，一人当たり畜産物の供給カロリーも伸ばし続けている（図１）。

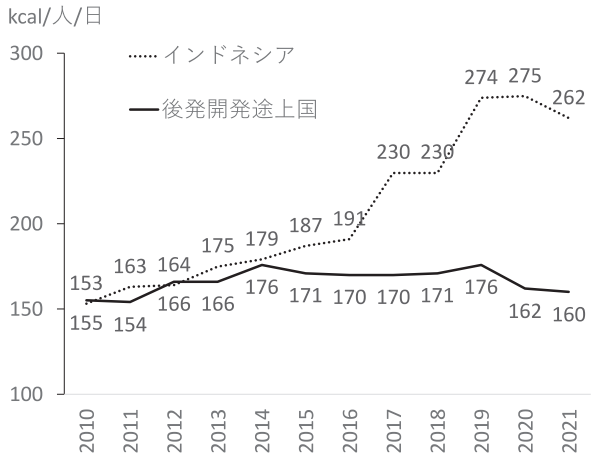

図１　１日あたりの畜産物の供給カロリーの推移
出所）FAOSTAT より筆者作成．

畜産物需要と生産の増加に伴い，飼料用穀物の需要も高い伸びが見込まれる。しかし，現地の酪農生産が実際にどのように対応しているのか，現状に関する知見は非常に限られている。そこで，成長を続けるインドネシアの酪農経営への聞き取り調査を実施した。本稿ではその結果について取りまとめ，インドネシアにおける酪農経営の実態と課題について考察することを目的とする。

調査地の概要

調査地が位置する東ジャワ州（Jawa Timur）は，ジャワ島東部に位置し，人口がジャカルタに次いで２番目に多いスラバヤが州都である。米作が中心で，西･中部ジャワに次ぐ国内有数の生産地である。そのほか高原地帯にはコーヒーやカカオの農園が見られる。今回の主な調査地である Jember は,州内で３番目に大きい都市と言われ，タバコ産業も有名な地域である。またインドネシア国内唯一のコーヒー・カカオ研究所が位置している。

また東ジャワは搾乳牛頭数が多い地域でもある。図２は,インドネシア統計局（Badan Pusat Statistik，以下，BPS）の農林業統計をもとに 2012 年から 2022 年までのインドネシア国内の地域別搾乳牛頭数の推移を示したものである。2022 年の国内の総飼養頭数が 60 万頭近くいるうち 50% 以上が東ジャワ州で飼養されている。

また表１はインドネシアにおける 2014 年の１頭あた

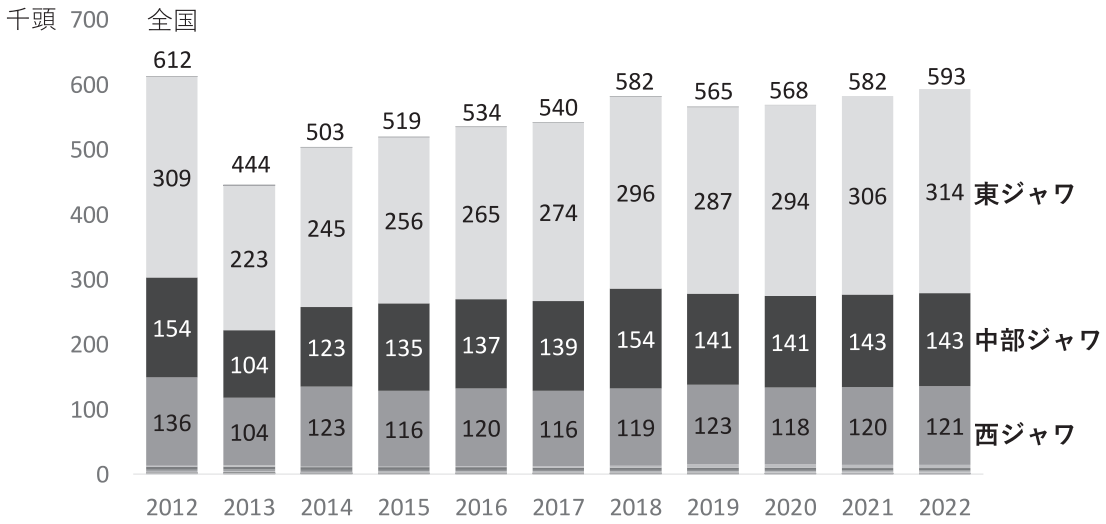

図２　インドネシアにおける地域別搾乳牛頭数の推移
出所）インドネシア統計局（BPS）

り乳量と１経営体当たりの搾乳頭数である。これはインドネシアの農林業センサスをもとに実施される標本調査である農家所得調査（Survei Pendapatan Usaha Rumah Tangga 2014,以下 SPP14）を用いて計算している。西ジャワの乳量は高い水準にあるが，中部と東ジャワは西ジャワの 50%強の水準でしか産乳できていない。ただし，10 年前のデータであることに留意されたい。

調査概要

調査は 2024 年 3 月 18 日に中核都市近郊の酪農家２戸，21 日に東ジャワの個別経営体が集中する Lumajang 市の酪農家に対して，経営概要に関して聞き取りを実施した。その結果を表２にまとめた。なお，当該期間はラマダン期間中であった。

表１　搾乳牛１頭あたりの乳量と飼養頭数

	西ジャワ	中部ジャワ	東ジャワ	（参考）北海道	（参考）都府県
年間乳量 (kg/頭/年)	8,999	4,980	4,888	9,187	9,051
日別乳量 (kg/頭/日)	29.5	16.3	16.0	30.1	29.7
搾乳頭数 (頭/経営体)	2.20	1.44	1.49	84.9	51.9

出所）SPP14、畜産物生産費統計（令和４年度）
注）日別乳量は年間搾乳日数を仮に 305 日として年間乳量を 305 で除したものである。

表２　経営の概要

		酪農家 H	酪農家 S	酪農家 R
地域		Jember	Jember	Lumajang
飼養頭数	搾乳牛	10	10	4
	乾乳牛	40	1	4
乳量		10 頭で 1 日 140L =14 L/日/頭	10 頭で 1 日 120L =12 L/日/頭	4 頭で 1 日 30L =7.5 L/日/頭
乳脂肪率		3–5%程度	–	把握していない
搾乳回数		AM4:00 と PM2:00 の２回	AM4:00 と PM2:00 の２回	AM4:00 と PM2:00 の２回
除籍産次数		8 年	–	8-10 年
生涯産次数		6-7 産	–	4-5 産
雇用労働力	飼料作	7 人	2 人	全部合わせて 2 人
	牛舎	4 人	1 人	
	搾乳	2 人	2 人	
乳価		Fat3%: 8,000Rp./L Fat4%: 10,000Rp./L Fat5%: 12,000Rp./L	12,000~14,000 Rp./L	高品質: 7,200 Rp./L 低品質: 7,100 Rp./L
副業の有無		有 生乳の直売	有 生乳の直売	有 小学校の教師 商店（doko）経営 ヤギの飼養
標高		455m	472m	792m

出所）聞き取り調査より筆者作成．
注）１Rp.=0.095 円（2024 年 4 月 23 日時点）

酪農家Hと酪農家Sは Jember 近郊の丘陵帯に位置している。中心部よりも標高が 400m ほど高く，平地よりも 2 度ほど低い環境で乳牛を飼養している。

１）経営の特徴

酪農家HとSは，都市中心部から北方向へ車で 30 分程度の所に位置している。生産した生乳を，所有する包装機械でパッキングし，仲卸業者，個人経営の飲食業者，個人に直接販売している。生乳は加熱処理する前の状態であり，包装袋に加熱調理の方法が記載されていた。酪農家Hはさらに加熱処理した生乳に甘みとフレーバーを添加して，店頭で販売している。酪農家Rの主業は，小学校の教師であり，他にも商店の経営など他の職を兼業している。乳牛の他にヤギも飼養しており，酪農業は父親が公的支援を受けて開始し，それを後継した。

２）産乳について

酪農家HとSの一日あたり乳量は 12 ～ 14 リットル程度で，10 年前のデータである表１の日別乳量と比較しても，ほぼ同水準と言える。酪農家Rは 2002 年に発生した口蹄疫の影響により，一度頭数を大きく減らし，産乳量も現在は低水準のままである。搾乳回数はいずれの経営も AM4:00 と PM2:00 の２回である。搾乳前に全身を洗浄するため，牛体は非常に清潔である。シャワーには２時間ほどかかるため，牛舎作業は AM2:00 と PM12:00 から開始する。

主な乳牛の品種はホルスタインではあるが，体型が小さい印象を受ける。種付けは人工授精で，多くはホルスタインをつけている。

また労働力は，雇用労働力であり，家族労働はほぼ見られなかった。年間を通じて青草が入手できるため，毎日飼料を収穫する労働力が必要である。

３）乳価について

酪農家HとSは直接販売しており，一部は仲卸業者に卸している。特に乳脂肪が高いほど顧客に好まれるとして，乳脂肪率に応じて取引価格が異なる。乳脂肪率 3% 未満の場合，１リットルあたり 8,000Rp. 程度であり，これを基準に乳脂肪率 1% 高くなる毎に 2,000Rp.（日本円で 20 円程度）乳価が高くなる。

一方,酪農家Rの乳価は,酪農家HとSよりも低く,リットルあたり 7,100 ～ 7,200Rp. である。酪農家Rは協同組合で集乳した後，乳業メーカー等に出荷しており，乳価は集乳後の２段階の品質に応じて決定される。精算は 10 日毎に行われるが，何を指標として品質が評価されているかは不明である。

飼料の概要

おもな粗飼料はエレファントグラス（Rumput Gajah, 図３）と飼料用トウモロコシである。これらの飼料を細断し，ほかの青草と混ぜて給与している。エレファントグラスはおよそ 9a で 100kg 程度収穫可能だが，飼料用トウモロコシよりも収量が低い。また，40 日程度で収穫可能となり，年間３～４回収穫できる。ただし，雨季を中心に成長するため，乾季の飼料確保が課題となっている。

図３　エレファントグラス

その他，濃厚飼料として粉状の米や豆腐粕，協同組合で販売している粉砕されたトウモロコシなどがミックスされたものや魚粉が給与されている（表３）。

表３　給与飼料の概要

	酪農家 H	酪農家 S	酪農家 R
雨季	エレファントグラス 飼料用トウモロコシ	エレファントグラス 飼料用トウモロコシ 粉状の米 豆腐粕 塩	エレファントグラス 他草類のミックス
乾季	飼料用トウモロコシ 粉状の米 豆腐粕	飼料用トウモロコシ 粉状の米 豆腐粕 塩	飼料用トウモロコシ 共同組合特製の濃厚飼料 魚粉

出所）聞き取り調査より筆者作成．

表４　雨季における飼料費の試算

雨季	酪農家 S		酪農家 R	
	給与量 (kg/月/頭)	費用 (Rp./月/頭)	給与量 (kg/月/頭)	費用 (Rp./月/頭)
自給飼料				
エレファントグラス	300	自給 (購入の場合, 150,000)	75	自給 (購入の場合, 37,500)
購入飼料				
粉状の米	0.4	200,000	-	-
豆腐粕	1	405,000	-	-
濃厚飼料	-	-	300	1,200,000
合計	-	605,000	-	1,200,000

出所）聞き取り調査より筆者作成．

飼料給与量と費用に関する試算

表４は具体的な給与量を聞き取ることができた酪農家 S と R の雨季における飼料給与状況をもとに，１ヶ月あたりの飼料費を推計したものである。主な自給飼料は，エレファントグラスであり，近隣農家から購入する場合には，100kg あたり 5 万 Rp. 程度である。また飼料用トウモロコシに関しては，自給や購入の両方のケースが見られたが，今回は具体的な価格について聞き取ることができなかった。

その他，濃厚飼料の代替として給与している粉状の米，豆腐粕，またミックスされた濃厚飼料はほとんど購入されており，酪農家 S で 60 万 Rp.，酪農家 R で 120 万 Rp. という計算となった。

表５　乳飼費の試算

	酪農家 H	酪農家 S	酪農家 R
飼養頭数（搾乳+乾乳）	50 頭	11 頭	8 頭
平均乳価 (Rp./L)	10,000	13,000	7,150
出荷乳量 (L/月)	4,200	3,600	900
乳代 (Rp./月)	42,000,000	46,800,000	6,435,000
購入飼料費	30,250,000	6,655,000	9,600,000
乳飼比	72.0%	14.2%	149%

出所）聞き取り調査より筆者作成 .

注）購入飼料費は表４で試算した１頭あたり購入飼料費に飼養頭数を乗じている。酪農家 H は酪農家 S の購入飼料費を用いて試算した。

乳飼費の試算

表５は，生乳出荷による収入と購入飼料費から各酪農家の乳飼比を計算したものである。その結果，酪農家 H の乳飼比 72% となった。

一方で，酪農家 S は，調査時点で飼養頭数 11 頭のうち搾乳牛頭数が 10 頭, 乾乳牛 1 頭という牛群構成であったため，他の経営体よりも極端に乳飼比が低い 14% という結果となった。

また，酪農家 R は 1 頭あたり乳量が他の経営体の半分程度しかないため，乳代だけでは，飼料費を補うことができない結果となった。ただし，口蹄疫が流行する 2012 年以前には,最も成績が良い時で,1 日 1 頭あたり 19 リットル程度の産乳があり，他の酪農家よりも高い水準であった。仮にこの水準であった場合，乳飼比を計算すると，およそ 59% となる。酪農家 R の乳価は，酪農家 H や S と比較して，7 割程度の低い乳価で取引されているが，それでも組合から購入している濃厚飼料費を十分カバーできる経営ができていたことになる。

日本の令和４年度の畜産物生産費統計では飼養頭数 1 ～ 20 頭未満規模の乳飼比は 51.1% であり，酪農経営における購入飼料の負担は，インドネシアの方がより逼迫した状況といえる。

おわりに

本稿は，インドネシアにおける酪農経営に対して実施した聞き取り調査をもとに，３戸の経営体に関してその実態を明らかにした。今回の調査では，１頭あたり産乳量は 10 年前とそこまで大きく変化していない可能性が指摘できる。また，簡易的ながら乳飼比を推計したところ，経営上の購入飼料費の負担は日本よりも大きい状況にあるといえる。

調査の最後に酪農家 R に経営上の課題は何かについて尋ねたところ，乾季の粗飼料が少ないこと，また濃厚飼料の入荷が不安定であり，飼料の入手可能性が脆弱であるとの回答があった。以上のことからインドネシアの酪農業における当面の課題として，以下の２点が指摘できる。第１に，搾乳牛１頭あたり産乳量の改善である。本調査は事例調査であり，サンプル抽出上の問題はあるが，都市近郊型で乳価が高い経営でも，10 年前の西ジャワの産乳量を達成していない。少なくとも国内の高水準まで乳量を向上させるための改善の余地はあるだろう。

また乳量向上を達成するためにも，第２として，自給飼料と購入飼料の確保と飼料構成の改善が必要である。本調査では，飼料設計まで調査・分析が及ばなかったが，明らかに粗飼料に相当するエレファントグラスの収量が

低く，また不足している。生乳の消費選好が乳脂肪分にある可能性もあり，需要に合わせて飼料構成の方向性を検討する必要はあるが，いずれにしろ国内での飼料増産に向けた取り組みは求められるだろう。

Abstract

Population growth and economic growth, mainly in the least developed countries, have led to a rapid increase in demand for protein sources such as meat and dairy products. Indonesia is no exception, as it is the only emerging economy that has continued to grow since the 2000s. On the other hand, there is very limited information on the actual status of dairy farming operations in tropical regions, and it is unclear how production sites are coping with the expected growth in demand and feed supply. Therefore, through a field survey, an overview of the management was compiled. As a result, it became clear that milk production was at about the same level as 10 years ago and that there were problems in securing feed for both roughage and concentrate feed.

Keywords: Indonesia, Tropical Dairy Farming, Small Scale Management, East Java, SPP14

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Historical Reduplication in Siraya*

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シラヤ語の歴史的重複語

落合いずみ

Abstract

This paper aims to provide supplementary data and analysis regarding the historically reduplicated forms in Siraya (Austronesian) in terms of the features mentioned in Adelaar (2011) and present a number of phonological features observed in these words. First, this paper provides an exhaustive data set of historically reduplicated forms with infixes <*al*> or <*ar*> or with an epenthetic vowel *a*, *i*, or *u* between a consonant cluster. It is proposed that the infixation had little impact on the meaning, and the phonetic realization of the epenthetic vowel was a schwa. Other features observed in historically reduplicated forms in Siraya are the devoicing of the C_2 in the historical root C_1VC_2, and the word-final change from *m* to *ŋ*. This paper also identifies the consonant D, which dates back to Proto-Austronesian *d, in historically reduplicated forms, which show alternation between *d* and *r* in the Gospel dialect but between *d* and *s* in the UM dialect.

Keywords: Siraya, Formosan, historical reduplication, internal reconstruction

* The earlier version of this paper was presented online at the 3rd Meeting of Research based on Dr. Shigeru Tsuchida's data on Formosan languages, March 26th, 2024. I appreciate the comments from the audiences at that time. However, the author is responsible for any errors remaining in this paper.

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1. Background

Siraya is a dormant Austronesian language once spoken in southwest Taiwan. It is one of many indigenous languages spoken on mainland Taiwan, which are collectively referred to as Formosan languages. According to Blust (1999: 45), ten first-order subgroups of Proto-Austronesian are recognized. Nine subgroups consist of Formosan languages. One of the nine subgroup is East Formosan, which includes languages such as Amis, Kavalan, Basay, and Siraya. Other subgroups consisting of Formosan languages are Atayalic (Atayal and Seediq), Northwest Formosan (Pazih and Saisiyat), Western Plains (Babuza, Hoanya, Papora, Thao, and Taokas), Tsouic (Tsou, Kanakanabu, and Saaroa), Rukai, Bunun, Paiwan, and Puyuma. The tenth subgroup is Malayo-Polynesian, which includes all Austronesian languages outside mainland Taiwan.

This paper deals with the historically reduplicated words in Siraya. Adelaar (2000) described various types of reduplicated forms in Siraya based on the data mentioned above. One of the types is called historical monosyllabic reduplication (Adelaar 2011: 61–62), which refers to the reduplicated forms of a monosyllabic root C_1VC_2, resulting in a disyllabic stem $C_1VC_2C_1VC_2$. This paper refers this type of reduplication simply as "historical reduplication." Adelaar (2011: 61–62) listed 17 attested words that present this historically reduplicated form such as *kurkur* "hoof" and *lawlaw* "nest." In this paper, the term "root" refers to the historical root C_1VC_2, and "stem" refers to the historically reduplicated form $C_1VC_2C_1VC_2$.

Adelaar (2011: 61–62) introduces two features seen in the historically reduplicated words in Siraya. One is the infixation of <*al*> or <*ar*>. These infixes are inserted in the historically reduplicated stem such as *p*<*al*>*ax-i-pix* "fine, refined." The other is epenthesis between a consonant cluster. A vowel *i* is inserted in a historical root C_1VC_2 (e.g., *pak-i-pak* "crumbs").

This paper aims to provide supplementary data and analysis regarding the historically reduplicated forms in Siraya for the features mentioned in Adelaar (2011) and present a number of additional phonological features observed in these words. Section 2 first introduces the background of the Siraya language including its written documents, orthography and phonemic inventory. Section 3 deals with stem extension by infixes <*al*> or <*ar*>. Section 4 discusses epenthesis in a consonant cluster. Section 5 examines devoicing of the C_2 in the historical root C_1VC_2, and Section 6 introduces some examples of the word-final change from *m* to *ŋ*. Section 7 identifies the consonant D in historically reduplicated forms that show an alternation between *d* and *r* in the Gospel dialect, but between *d* and *s* in the UM dialect. Section 8 summarizes the observations discussed above.

The Appendix shows the data for historical reduplication used in this paper. All available data for the historically reduplicated forms are taken from Adelaar (2011) and Murakami (1933), which deal with Bible translations in Siraya and the Utrecht Manuscript, respectively.

2. Background of Siraya language

In the 17th century, the Dutch colonized the southwest region of Taiwan and came into contact with the Siraya people. The Siraya language was documented in a translation of the Bible and catechisms (Gravius 1661, 1662). It was also documented in a collection of documents called the Utrecht Manuscript (Van der Vlis 1842), which was supposedly

[1] The present author also referred to Campbell (1888) for the content of Gravius (1661). Campbell (1888) is a republished version of Gravius (1661) with English translations.

written in the 17th century.[1] After these contacts with the Dutch and the subsequent influx of Chinese farmers, the Siraya language gradually fell into disuse and was in danger of extinction. When Japan colonized Taiwan in the late 19th century, the Siraya language was highly endangered. Therefore, the documents mentioned above are considered a valuable source of language data.

The Siraya language documented in the 17th century is said to have two dialects. The dialect documented by Gravius (1661, 1662) is called the Gospel dialect, indicated by (G) in the Appendix, and the other dialect was documented in the Utrecht Manuscript, referred to as the UM dialect and indicated by (U) in the Appendix. The phonemic inventory of Proto-Siraya deciphered by Adelaar (2014: 24) are as follows: six vowels /a, e, i, o, u, ə/, four word-final diphthongs /-aw, -iu, -ay, -uy/, and 16 consonants /p, b, t, d, k, m, n, ŋ, l, r, s, ð, ɣ, x, h, w, y/.[2] Adelaar (2011: 52–53) explains that the consonant /b/ is transcribed either as *b* or *v* in the Gospel dialect. In this paper, the orthography used by Gravius (1661, 1662) and Van der Vlis (1842) are interpreted phonemically and transliterated to a simpler writing system for the ease of discussion.

3. Infixation of <al> and <ar>

Adelaar (2011: 61–62) listed six historically reduplicated forms infixed with <*al*> or <*ar*>. Table 1 shows an exhaustive list of historically reduplicated stems appearing with infixes <*al*> or <*ar*> found in Adelaar (2011) and Murakami (1933), including five forms with <*al*> and thirteen forms with <*ar*>. The attested forms recorded in Adelaar (2011) and Murakami (1933) have, in some cases, affixes attached; i.e., a prefix, suffix, infix or a combination. These attested forms are shown in the Appendix. The forms shown in the left column in Table 1 have these affixes

Table 1 Infixation of <*al*> and <*ar*> in the historically reduplicated forms in Siraya

Stem forms based on records	Analyzed underlying forms	Gloss
d<al>iŋdiŋ	/diŋdiŋ/	“pleased”
k<al>awkaw	/kawkaw/	“rumor”
k<al>uŋkuŋ	/kuŋkuŋ/	“nail”
p<al>impuŋ	/pəməm/	“calm”
p<al>ixpix	/pixpix/	“fine, refined”
t<al>uktuk	/tuktuk/	“hat”
v<ar>iŋbiŋ	/biŋbiŋ/	“to do with vehemence”
v<ar>ixbix	/bixbix/	“to bore, drill”
v<ar>utvut	/butbut/	“uproar”
h<ar>afhaf	/habhab/	“troubled”
h<ar>adhat	/hadhad/	“to use an idle flood of words”
h<ar>ilhil	/hilhil/	“smooth”
k<ar>amkam	/kamkam/	“ant”
k<ar>iskœs	/kəskəs/	“horror”
k<ar>utkut	/kutkut/	“creek”
p<ar>ilpil	/pilpil/	(Meaning unclear)
p<ar>ukpuk	/pukpuk/	(Meaning unclear)
s<ar>amsam	/samsam/	“useless”
t<ar>ivtip	/tibtib/	“mussel”

[2] In Adelaar (2014: 12–13), /l/ is represented as l with a bar in the middle (i.d., “ɬ”).

deleted. The middle column proposes the underlying forms of the historically reduplicated stems shown in the left column.

Adelaar (2011: 61–62) does not mention the function of these infixes <*al*> and <*ar*>. This paper regards <*ar*> in Sirraya as the reflex of the Proto-Austronesian infix *ar. According to Blust (2013: 389–392), this infix indicates plurality. The other infix in Siraya, <*al*>, might have been innovated after the model of <*ar*>. However, as far as the data in Table 1 shows, it is uncertain if the forms with <*al*> or <*ar*> have plural meanings.

Although the function of <*al*> and <*ar*> is unclear, one minimal pair suggests that the infixation has little influence on its stem's meaning. For the sixth form, *t*<*al*>*uktuk*, a minimal pair without the infix <*al*>*, tuktuk*, is observed. Their meanings are closely connected: *tuktuk* means "skull, crown, top" and *t*<*al*>*uktuk* means "hat." The two forms overlap in the meaning of "crown" and "hat," which share the meaning "something to be worn on a head." In this case, it can be said that the infixation of <*al*> has little influence on the meaning. It remains unknown if it derives the plural meaning.

The infixation of <*ar*> and <*al*> in Siraya likely was applied exclusively to the historically reduplicated forms. Tsuchida and Li (2009: 348) lists eleven Siraya forms with the infix <*ar*> or <*al*>. Among these forms, all the stems (roots) are historically reduplicated forms according to Ochiai (2022: 14). The cognate infixes are also seen in Formosan languages, as observed in Tsuchida and Li (2009). Ochiai (2022: 14–17) notes that among the forms with such infixes, the stems are historically reduplicated in the majority of cases in the date for all Formosan languages (except for Atayalic languages) reported in Li and Tsuchida (2009), including Siraya.

In short, the infixation of <*al*> or <*ar*> in Siraya is seen only in historically reduplicated forms. This infixation in the historically reduplicated forms is typological in other Formosan languages, while its function in Siraya remains unknown.

4. Epenthesis in a consonant cluster

Adelaar (2011: 62) lists five examples of historically reduplicated forms with a linking vowel *i*. This vowel is inserted in a consonant cluster C_2C_1 in the middle of the historically reduplicated stem $C_1VC_2C_1VC_2$. Table 2 shows an exhaustive list of historically reduplicated stems with an epenthetic vowel within the consonant cluster found in Adelaar (2011) and Murakami (1933). Four stems appear with the epenthetic vowel *i* as mentioned in Adelaar (2011:

Table 2 Epenthesis in a consonant cluster in Siraya

Stem forms based on records	Analyzed underlying forms	Gloss
vutivut	/butbut/	"uproar"
dilidil	/dildil/	"to tremble"
pakipak	/pakpak/	"crumbs"
ripirip	/riprip/	"waist (?)"
vuravur	/burbur/	"dust"
kawakaw	/kawkaw/	"rumor"
pukapuk	/pukpuk/	(Meaning unclear)
rakarak	/rakrak/	"recalcitrant"
raŋaraŋ	/raŋraŋ/	"leopard"
rivarif	/ribrib/	"to forget"
tivatip	/tibtib/	"mussel"
haduhat	/hadhad/	"to use an idle flood if words"
kamukam	/kamkam/	"ant"

62). However, there are other epenthetic vowels: *a* and *u*. Seven stems appear with the epenthetic vowel *a* and two stems appear with the epenthetic vowel *u*.

In historically reduplicated forms in Seediq, another Formosan language, a schwa is inserted in the consonant cluster (Ochiai 2018); e.g., *bələbul* < Proto-Seediq *bələbəl < Proto-Austronesian *bəNbəN "banana."[3] In a similar manner, the epenthetic vowel in Siraya could be a schwa, which is transcribed by the variant letters *a*, *i*, or *u*. The Dutch orthography lacked a letter representing a schwa, and Adelaar (2011: 19–20) points out that this vowel is transcribed by various letters such as *i*, *u*, *e*, or an apostrophe (') or by the nonexistence of a letter. The various representations of the epenthetic vowels in the historically reduplicated stems suggest its identity as a schwa.

In addition, the epenthesis is not obligatory. As seen in the Appendix, there are attested forms without epenthetic vowels such as *bikbik* "to shake the head" and *vixbix* "lip."

5. Root final devoicing

In the historically reduplicated forms $C_1VC_2C_1VC_2$, the coda C_2 of the historical root C_1VC_2, either the first C_2, the second C_2 or both, is sometimes devoiced. The consonant C_2 is either /b/ or /d/. These forms are shown in Table 3.

This paper regards the C_2 as voiced if one of the C_2's appears in letters indicating a voiced consonant such as *b* (and its written variant *v*) and *d*. The first C_2 is devoiced in the stems from (1) to (4). The first C_2 is devoiced in the stem (5).

For the stems from (6) to (10), both C_2s indicate devoiced consonants such as *p* (and its written variant *f*), and *t*. In *hafhaf* (11) and *tuftuf* (8), the letter *f* appears as C_2. However, /f/ is not included in the phoneme inventory. Adelaar (2014: 6) suggests that a word-final /b/ can appear as the letter f in both Gospel and UM dialects. The letter "f" likely represents the consonant *v*, the written variant of *b*, with devoicing.

Table 3 Root final devoicing in historically reduplicated forms in Siraya

	Stem forms based on records	Analyzed underlying forms	Gloss
(1)	*hadhat*	/hadhad/	"to use an idle flood of words"
(2)	*ladlat*	/ladlad/	"to scratch one's body"
(3)	*rivrif*	/ribrib/	"to forget"
(4)	*tivtip*	/tibtib/	"mussel"
(5)	*xitxid*	/xidxid/	"to trample on"
(6)	*xitxit* (variant of (5))	/xidxid/	"to trample on"
(7)	*hafhaf*	/habhab/	"troubled"
(8)	*tuftuf*	/tubtub/	"fatling"
(9)	*kəpkəp* (variant as *kəbkəb*)	/kəbkəb/	"brood"
(10)	*pitpit* (variant as *pidpid*)	/pidpid/	"hem"

[3] The Proto-Austronesian form for "banana" is taken from Blust and Trussel (2010). Ochiai (2018: 28) reconstructs the Proto-Seediq for "banana" as *buləbul with the vowel *u* in the historical root. However, this paper modified this form to *bələbəl based on the Proto-Austronesian form as the modified form is the direct reflex with regular sound correspondences of the Proto-Austronesian form *bəNəbəN. In addition, the historical shwa in the final syllable in Seediq changes to *u* (Ochiai 2018: 25–26) as seen in *bələbul*.

For the stems *kəpkəp* (5) and *pitpit* (6), both C_2s appear as the letter *p* or *t*, indicating voicelessness. However, they have variants with a voiced C_2, *kəbkəb* and *pidpid*, respectively. Therefore, this paper considers their underlying forms have a voiced C_2. For *xitxid* (5) and *xitxit* (6), the undevoiced variant *xidxid* is attested.

Table 3 showed that for historically reduplicated forms with a voiced C_2 (either *b* or *d*), either the first C_2, second C_2 or both C_2s can be devoiced. The devoicing is not conditioned as undevoiced variants are also attested. The root final devoicing is said to be an optional phonetic change.

A similar sound change is observed in Seediq. Seediq has two dialects: Paran Seediq and Truku Seediq. The historical word-final *b* and *d* in both dialects become devoiced consonants *k* and *t*, respectively.[4] The change from *b* to *k* likely underwent an intermediate stage *p*, which has the same place of articulation as *b*, and then *p* changed its place of articulation from labial to velar (i.e., *b* > *p* > *k*). The historical word-final consonant is recovered when suffixed. To take an example of historically reduplicated forms, the word for "covered with evaporation" in Truku Seediq is *həbəhuk* and the word-final *k* becomes *b* in *həbəhəb-an*, a derived form with a suffix *-an*, which designates undergoer voice location subject. The word for "to scratch" in Truku Seediq is *gədəgut* and the word-final *t* becomes *d* in *gədəgud-an*.

In Seediq, it is only the stem final consonant, the second C_2, in historical reduplicated forms that underwent devoicing. It does not apply to a medial C_2. Historically reduplicated forms in Siraya differ from those in Seediq in that the first C_2 can also undergo devoicing.

6. Stem or root final m to ŋ

In some historically reduplicated forms shown in Table 4, the root final consonant *m* is changed to *ŋ*. In *pimpuŋ* (11), the first C_2 appears as *m* and the second C_2 is changed to *ŋ*. Forms in (12) and (13) originate in the same underlying form /dəmdəm/ "dark, inscrutable" as discussed in Section 7. Other representations of this form are, for example, *rimdim* and *rumdum* as seen in Table 4. In the forms seen in (12) and (13), both the first C_2 and the second C_2 are changed to *ŋ*.

This phonological change observed in historically reduplicated forms in Siraya suggests that this change may have occurred word-finally in non-historically reduplicated forms.

According to Ochiai (2018: 27), Paran Seediq underwent

Table 4 Stem or root final *m* to *ŋ* in Siraya

	Stem forms based on records	Analyzed underlying forms	Gloss
(11)	*pimpuŋ*	/pəmpəm/	"calm"
(12)	*ruŋduŋ, siŋdiŋ*	/dəmdəm/	"thunder"
(13)	*diŋdiŋ, duŋdiŋ, duŋduŋ*	/dəmdəm/	"to judge"

[4] Ochiai (2016: 112–113) synchronically described the change of word-final *k* to *b*, word-final *c* [ʦ] (which was originally *t* but changed to c word-finally) to *d* and others under suffixation in Paran Seediq. Based on these synchronic sound changes, she inferred that the word-final consonant under suffixation, such as *b* and *d*, shows a historically older segment. For Truku Seediq, Tsukida (2009: 118–121) synchronically described the change of word-final *k* to *b* and word-final *t* to *d* under suffixation synchronically in Truku Seediq. Historically reduplicated forms in Seediq reported in Ochiai (2018) with the first C_2 as *b* or *d* reinforces the second C_2's historical origin as *b* or *d*.

a similar change where a word-final *m* changed to *ŋ*. However, in historically reduplicated forms in Paran Seediq, it is only the stem final m which undergoes the change to *ŋ*. This change does not apply to a medial *m*, which corresponds to the first C_2; e.g., *pumepaŋ* < Proto-Seediq *pampam "astringent" (The Proto-Seediq form in Ochiai (2018: 29) was *pəmpəm, but is revised to *pampam in this paper. The antepenultimate vowel *u* represents a weakened vowel, and the penultimate vowel e was historically a schwa in Paran Seediq). Siraya forms in (16) and (17) differ in that the first C_2 also underwent the change to *ŋ* as well as the second C_2, a word-final consonant.

7. Identification of consonant D in historically reduplicated forms in Siraya

Adelaar (2012: 53–55) included a consonant D in the phonemic inventory of Siraya and states that this reflects the Proto-Austronesian consonant *d. This phoneme appears either as the letter d or r in the Gospel dialect (Adelaar 2012: 53–55), indicating that the phoneme is realized either as [d] or [r]. This paper did not include "D" in the phonemic inventory as its realizations, *d* and *r*, are both included in the phonemic entry.

Adelaar (2014: 10) explains that the consonant D in the Gospel dialect generally appears as the letter d in the word-initial position and consonant clusters whereas the letter *r* also appears intervocalically and word-finally. However, both letters d and r sometimes occur word-initially.

In the data for historically reduplicated words of $C_1VC_2C_1VC_2$ from the Gospel dialect, there are cases where the consonant C_1 is considered "D" as the first C_1 appears as *r* and the second C_1 alternates to *d*, as shown in Table 5. The second C_1 appears as *d* as it is in the consonant cluster C_2C_1.

In the data for historically reduplicated words of $C_1VC_2C_1VC_2$ from the Gospel dialect, there are also cases where the consonant C_1 is considered "D" as the first C_1 appears as *s* and the second C_1 alternates to *d* as shown in Table 6. The second C_1 appears as *d* as it is in the consonant cluster C_2C_1.

The forms in (15), (16), (17), (20) and (21), with an identical underlying form, likely have a single origin. Adelaar (2014: 11) points out Proto-Siraya *dəmdəm meaning "dark, inscrutable" derives a meaning "thoughts," which is related

Table 5 Identification of the consonant D in historically reduplicated forms in the Gospel dialect of Siraya

	Stem forms based on records	Analyzed underlying forms	Gloss
(14)	*raŋdaŋ*	/daŋdaŋ/	"leopard"
(15)	*rimdim*	/dəmdəm/	"dark"
(16)	*ruŋduŋ*	/dəmdəm/	"thunder"
(17)	*rumdum*	/dəmdəm/	"thought"

Table 6 Identification of the consonant D in historically reduplicated forms in the UM dialect of Siraya

	Stem forms based on records	Analyzed underlying forms	Gloss
(18)	*sakdak*	/dakdak/	"to hop"
(19)	*saŋdaŋ*	/daŋdaŋ/	"to roast on a spit"
(20)	*simdim*	/dəmdəm/	"dark"
(21)	*siŋdiŋ*	/dəmdəm/	"thunder"

to "to remember" (e.g., *dimdim* in the Appendix means "to remember"). This paper considers darkness is related to massive clouds, which leads to thunder and a downpour (e.g., *dumdum* in the Appendix means "torrential rain, downpour"). As the verb in the historical root appears as *i* or *u* in forms from (15), (16), (17), (20) and (21), Adelaar (2014: 11) likely reconstructed this vowel as a schwa; i.e., *dəmdəm.[5]

According to Adelaar (2011: 55) and Adelaar (2014: 10), the consonant D is transcribed either as the letter *d* or *s* in the UM dialect. The letter *d* can appear in a consonant cluster, while the letter *s* appears in other positions.

8. Summary

This paper provided supplementary data regarding historically reduplicated forms in Siraya and presented an analysis of these forms. Historically reduplicated forms with infixes <*al*> or <*ar*> are presented, and it is suggested that the infixation had little influence on meaning. The data showing epenthetic vowels transcribed either as *a*, *i,* or *u* are also presented, and it is proposed that the epenthetic vowel is a schwa.

Other features seen in historically reduplicated forms include devoicing of the root final consonant C_2, in which both the first and second C_2 can undergo devoicing. Further, the stem-final *m* (second C_2) changes to *ŋ* or the root final *m* (first and second C_2) changes to *ŋ*. This paper also identified the consonant D in the position C_1 in the historically reduplicated forms, which showed an alternation between *d* and *r* in the Gospel dialect but between *d* and *s* in the UM dialect.

These phonological and morphological characteristics observed in historically reduplicated forms $C_1VC_2C_1VC_2$ in Siraya discussed in Sections 3 to Section 6 are summarized in Fig. 1 (the parentheses mean that the element is optional). The sound changes under the first and second C_2, devoicing (*d* > *t* and *b* > *p*) and the nasal change *m* > *ŋ*, show that the changes are possible in these positions.

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Fig.1 Phonological and morphological characteristics seen in historically reduplicated forms in Siraya

C1(<al>/<ar>)	V	C2	-(ə)-	C1	V	C2
		d > *t*				*d* > *t*
		b > *p*				*b* > *p*
		m > *ŋ*				*m* > *ŋ*

[5] Adelaar (2014: 11), however, reconstructed the consonant C_1 as *ð.

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Appendix

The middle column shows historically reduplicated forms collected from the glossaries in Adelaar (2011) and Murakami (1933). The former forms are indicated by (G) and the latter by (U). The left column shows reconstructed stems based on the forms in Adelaar (2011) or Murakami (1933).

Stem	Identified forms	Gloss
bikbik	bikbik (G)	"to shake the head"
biŋbiŋ	va-v<ar>iŋbiŋ (G)	"to do with vehemence"
bixbix	vixbix (U)	"lip"
bixbix	v<ar>igbig (U)	"to bore, to drill"
bitbit	bitbit (U)	"to stretch one's body"
bukbuk	bukbuk (G), vukbuk (G), bukbuk (U)	"to beat, to strike"
butbut	ka-v<ar>ut-i-vut-an (G)	"uproar"
bəlbəl	bulbil (U)	"banana tree"
bulbul	bulbul (G)	"to destroy (?)"
burbur	var-a-vur (G)	"dust"
dakdak	s<m>akdak (U)	"to hop"

daŋdaŋ	s<m>aŋdaŋ (U)	“to roast on a spit”
daŋdaŋ	raŋdaŋ-ən (G)	(meaning unclear)
dapdap	dap-u-dap (G)	“region (?)”
dildil	dil-i-dil (G), ma-dil-dil (U)	“to tremble”
diŋdiŋ	d<al>iŋdiŋ (G)	“pleased”
dəmdəm	pax-dimdim (U)	“to remember”
	da-rimdim (G), da-rumdum (G)	“thoughts”
	diŋdiŋ (G), duŋdiŋ (G), duŋduŋ (G)	“to judge”
dəmdəm	ma-rimdim (G), ma-simdim (U)	“dark”
	ka-rumdum-an (G)	“darkness”
dəmdəm	dumdum (G)	“torrential rain, downpour”
	ruŋduŋ (G), siŋdiŋ (U)	“thunder”
habhab	ma-h<ar>afhaf	“troubled”
hadhad	maku-h<ar>ad-u-hat (G)	“to use an idle flood of words”
halhal	halhal (U)	“mat”
harhar	ma-saw-harhar (G)	“merciful, compassionate”
hilhil	h<ar>ilhil (U)	“smooth”
kamkam	k<ar>am-u-kam (U)	“ant”
kawkaw	k<al>aw-a-kaw (G)	“rumor”
kəlkəl	ma-kilkil (G), ma-kulkul (G)	“dedicated, serious, industrious”
kəskəs	ka-k<ar>iskæs-an (G)	“horror, abomination”
kaxkax	kuxkæwx (G)	“to dig through, to break in”
kidkid	ni-pu-u-kidkid-en (G)	“filled”
kidkid	ma-kidlid (G)	“faithful”
kiŋkiŋ	kiŋkiŋ-iŋ (U)	“to burn something in a pan”
kiskis	k<m>iskis (U)	“to snore”
kitkit	ma-kitkit (G)	“stingy”
kulkul	ma-saw-kulkul (G)	“to regard, discriminate (?)”
kuŋkuŋ	k<al>uŋkuŋ (U)	“nail”
kurkur	kurkur (G)	“feet of a pig”
kuskus	k<m>uskus (U)	“to comb the hair with the fingers”
kutkut	k<ar>utkut (G), k<ar>utkut (U)	“creek, small river”
kutkut	k<m>utkut (U)	“to read, to count”
kəbkəb	ma-kipkip (U)	“to brood, to hatch”
	kubkub (G)	“brood, offspring of animals”
laklak	mi-laklak (G)	“to wither, to become dry”
lawlaw	lawlaw (G)	“nest”
liplip	liplip (U)	“dried palm leaf”
lislis	l<m>islis (U)	“to sweep something away with the hands”
ladlad	l<m>adlat (U)	“to stretch one’s body, to put out one’s tongue”
malmal	malmal (U)	“all kinds of spices”
pakpak	pak-i-pak (G)	“crumbs”
pəmpəm	p<al>impuŋ (U)	“calm, still”
	p<al>iŋpiŋ (G)	“to become calm, cease (wind)”
pidpid	na pa-pidpid (G)	“hem”
	pa-pitpit (G)	“hem, seam”

pilpil	p<ar>ilpil (G)	(Meaning unclear)
pispis	pispis (U)	“to feel, to grope”
pixpix	p<al>ixpix (G), pi(x)pix (G)	“fine, refined”
pukpuk	p<ar>uk-a-puk (G)	(Meaning unclear)
rabrab	t<m>-awki-rav-i-raf (G)	“to twist (words)”
rakrak	ma-rak-a-rak (G)	“recalcitrant”
raŋraŋ	raŋ-a-raŋ	“leopard”
ribrib	mu-riv-a-rif (U)	“to forget”
riprip	rip-i-rip (G)	“waist (?)”
samsam	s<ar>amsam (G)	“useless”
	saŋsaŋ (G)	“restless, noisy”
sapsap	s<m>apsap (U)	“to touch, to feel”
siksik	siksik-aw (G)	“to stretch out”
simsim	simsim (G)	“needle”
sipsip	s<m>ipsip (U)	“to cure, to work”
taktak	taktak (U)	“chin”
taktak	taktak-aw (G)	“to break (?)”
taltal	taltal (U)	“bridge”
taptap	taptap-ey (G)	“to shake off”
tibtib	t<ar>iv-a-tip (U)	“mussel”
tiktik	ma-tiktik	“just, righteous, fair, honest”
tiktik	t<m>iktik (G)	“to nail”
tiltil	tiltil (U)	“foot”
tintin	tintin (G), tintin (U)	“heart”
tiŋtiŋ	ta-tiŋtiŋ-an (G)	“scales, weighing instrument”
tubtub	ni-tuftuf (G)	“fatling”
tuktuk	tuktuk (G)	“skull”
	t<al>uktuk (G)	“hat”
	tuktuk (U)	“crown, top”
tuktuk	ta-tuktuk (U)	“bill”
tuntun	ma-tuntun (G)	“to cast out”
təbtəb	t<m>ubtib (G)	“to knock”
	t<m>iptip (U)	“to knock at the door”
	tubtub (G)	“to beat”
xidxid	x<m>itxid (G), x<m>ithit (U), xitxit (G)	“to trample on, to tread on”
xitxit	xitxit (U)	“curve of the back”

概　要

Adelaar（2011）にはシラヤ語（台湾オーストロネシア諸語の一言語）における歴史的重複語に関する観察が挙げられるが、用いられたデータは部分的なものであった。本稿はまず歴史的重複語のデータを補完し、それをもとに更なる観察を加える。まずシラヤ語の歴史的重複語において接中辞〈*al*〉または〈*ar*〉が含まれる語と重複要素 C_1VC_2 の境界に母音 *a*、*i* または *u* が付加される語を特定した。その上で、接中辞の挿入は意味的影響を及ぼさないこと、挿入母音は曖昧母音が想定されることを主張した。その他に、重複要素 C_1VC_2 の第二子音 C_2 が有声の場合は無声化される傾向があること、C_2 が鼻音 *m* の場合は *ŋ* に変化する傾向があることも明らかにした。さらに、シラヤ語の子音 D（オーストロネシア祖語 *d から変化した）を含む歴史的重複語を子音交替の特徴を基に特定した。先行研究によるとこの子音はシラヤ語の一方言である Gospel 方言では *d* と *r* 間で交替し、もう一つの方言である UM 方言では *d* と *s* 間で交替する。

キーワード：シラヤ語　台湾オーストロネシア諸語　歴史的重複　内的再建

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8 ヶ月間の「ちくだい KIP 体操プログラム」が児童の身体形態と体力に及ぼす影響～第 3 期

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Effect of the 8-months "Chikudai KIP exercise Program" on children's morphological and physical fitness data. ~3rd

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摘　要

本研究は一般社団法人ちくだい KIP による 8 ヶ月間の体操教室が上士幌町在住小学生（1 ～ 3 年生）の身体形態と体力に及ぼす影響について調査すること、および当該プロジェクト第 1 期から第 3 期までを総合的に振り返り、地方における子どもの体力向上コミュニティの育成的運営に対する長期ビジョンを提示することを目的とした。

6 歳から 9 歳までの 24 名が全ての介入前後測定を実施した。介入前後で身体形態データとして身長、体重、大腿長、大腿周囲径、大腿前部筋厚の測定、体力データとして新体力テストを実施した。プログラムは前年を踏襲した体操教室と、その前後にストレッチングや基礎的な筋力トレーニング、走・跳・投運動の段階練習などを取り入れた。また、1 ヶ月に約 1 回程度、上士幌町スポーツ少年団により様々なスポーツの体験会が実施された。

介入前後、形態データは身長、体重、大腿長、大腿直筋厚、大腿直筋＋中間広筋厚、中間広筋厚が有意に増加した（$p<0.01$）。体力データは、上体起こし、50m 走（$p<0.05$）、反復横とび（$p<0.01$）が有意に向上した。これまで第 1 期、第 2 期と介入前後で変化がなかった大腿前部筋厚について第 3 期のみ変化があったことから、参加経験でソートし、初参加群 12 名とリピート群 12 名の比較を試みた。その結果、筋厚が増加していたのはリピート群のみで、初参加群は増加していなかった。

本プログラムは体力測定値改善に対しては即効性が高く、筋厚に対しては非常に遅く 2 ～ 3 年かかることを示している。これからの地方における子どもたちの体力向上において、都市部との生活環境の差異を考慮することと、継続する（提供者側も「継続する」）ことの重要性が確認された。

キーワード：子ども、体力、器械運動

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1. 目的

第１期[1]では、参加者の介入前後の自然成長（身長・体重・大腿長の増加）こそは確認されたものの、大腿周囲径、大腿前部筋厚に統計的な変化は認められなかった。その点、体力データは握力以外が有意な向上をみせ、そのうちの４種目（上体起こし・長座体前屈・反復横とび、立ち幅とび）が全国平均値を上回った。

第２期[2]では、参加者の介入前後の自然成長（身長・体重・大腿長）に加え、大腿周囲径も有意に増加したが、やはり大腿前部筋厚が統計的な変化を示すことはなかった。体力データは第１期を上回る向上率を示し、全ての測定値が有意に向上、全国平均値をも上回った。

これまでの結果から、小学１～３年生が「ちくだいKIP体操プログラム」を約１年間継続すると、体力データは軒並み向上することがわかった。形態データに関しては身体の長軸方向の自然成長がメインとなり、運動習慣を獲得しても大腿前部筋厚が増加するには至らないと考えられた。しかしながら、船津ら[3)4)]が実施した大規模な筋厚測定では６歳から８歳（今回対象とした小学１～３年生）において大腿前部筋厚に有意な年齢の主効果が認められ、年齢が上がるにつれて筋厚が高い値を示すことを報告している。つまり、自然成長によっても大腿前部筋厚に変化が生じる可能性があることを示しており、本研究とは異なっている。

したがって本研究は、2021年度に開始された上士幌町教育委員会と一般社団法人ちくだいKIPによる子どもの体力向上プロジェクト「かみしほろ　のびのびキッズ！」第３期2023年度の結果報告、ならびにプログラム参加児童の体力向上状況および大腿前部筋厚変化の再検討を目的とした。さらに、第１期から第３期までを総合的に振り返り、地方における子どもの体力向上コミュニティの育成的運営に対する長期ビジョンを提示することを目的としている。

2. 方法

被験者は上士幌町教育委員会が募集し、当該プロジェクトに同意した小学１～３年生の35名であった。そのうち24名が全ての介入前後測定に参加した（11名は諸事情により途中参加であったため事前測定ができなかった）。体力向上プログラムは2023年６月７日に開始され、2024年１月31日まで全29回（うち測定４回）にわたり継続された。介入前後に形態データとして身長、体重、大腿長、大腿周囲径、大腿前部筋厚を測定し、体力データとして新体力テスト（握力・上体起こし・長座体前屈・反復横とび・20mシャトルラン・50m走・立ち幅とび・ソフトボール投げ）を実施した。大腿前部筋厚は超音波画像診断装置（HS-2000, 本多電子社製）を使用し、装置内のスケールツールを用いて計測した（図１；2021年度報告より引用）。

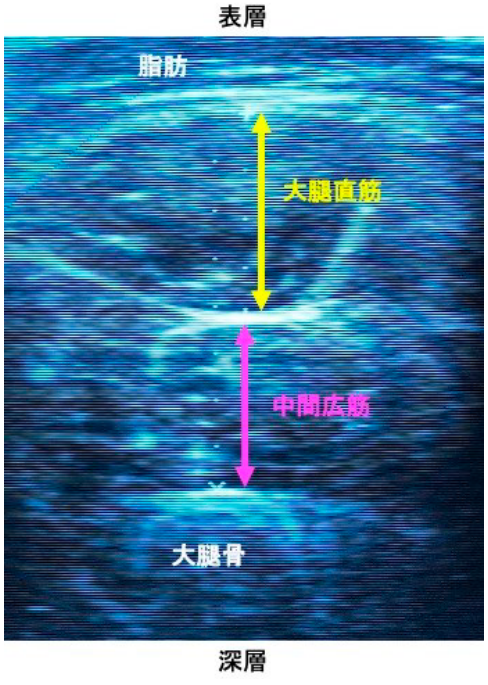

図１. 超音波診断装置による大腿前部筋厚測定
（2021年度報告より引用）

運動プログラムは一般社団法人ちくだいKIPで実施されている体操教室マニュアルに沿って実施された。主に使用した器具はマット、とび箱、低鉄棒およびトランポリンであり、全て上士幌町の備品として準備された。ま

た、器械運動の前や後に大腿部や股関節のストレッチング、上体起こしや腕立て伏せなどの基礎的な筋力トレーニング、走・跳・投運動の段階練習を取り入れた。指導は可能な限り2人体制で実施した。また、1ヶ月に1回程度、上士幌町スポーツ少年団により様々なスポーツ体験会が実施された。

全ての測定値は平均値±標準偏差で示した。分析にはMicrosoft Excel for Mac version 16.83を使用し、介入前後の差は対応のあるt検定を用いた。有意水準は5%未満とした。

3. 結果

介入前後の形態データを表1に、体力データを表2に示した。

形態データは身長、体重、大腿長、大腿直筋厚、大腿直筋＋中間広筋厚、中間広筋厚が有意に増加し（$p<0.01$）、大腿周囲径に変化は認められなかった。

体力データとして測定された新体力テストは、上体起こし、50m走（$p<0.05$）、反復横とび（$p<0.01$）が有意に向上した。握力、上体起こし、長座体前屈、反復横とび、20mシャトルランは令和4年度の全国平均値と同等か上回っていたが、50m走、立ち幅とび、ソフトボール投げは下回っていた。

表1. 介入前後の身体形態測定値（平均値±標準偏差）

(n=24)

測定項目	介入前	介入後	統計的差
身長 (cm)	123.6 ± 7.7	126.7 ± 7.8	**
体重 (kg)	25.7 ± 4.6	27.5 ± 5.3	**
大腿長 (cm)	29.4 ± 2.4	30.8 ± 2.5	**
大腿周囲径 (cm)	36.5 ± 3.0	37.5 ± 3.7	n.s.
大腿直筋厚 (mm)	14.5 ± 2.1	16.0 ± 2.2	**
大腿直筋＋中間広筋厚 (mm)	29.8 ± 4.5	32.8 ± 4.2	**
中間広筋厚 (mm)	15.4 ± 3.1	16.8 ± 3.0	**

(*p<0.05, **p<0.01)

表2. 介入前後の体力測定値（平均値±標準偏差）

(n=24)

測定項目	介入前	介入後	統計的差	R4：6～9歳 全国平均値
握力 (kg)	10.8 ± 3.4	11.4 ± 3.5	n.s.	11.4
上体起こし (回)	16.0 ± 6.1	18.3 ± 3.5	*	14.8
長座体前屈 (cm)	31.0 ± 6.6	33.4 ± 6.0	n.s.	30.6
反復横とび (回)	33.1 ± 7.6	38.0 ± 6.5	**	32.3
20mシャトルラン (回)	29.3 ± 18.1	32.4 ± 20.2	n.s.	27.8
50m走 (秒)	11.7 ± 1.8	11.0 ± 1.0	*	10.6
立幅とび (cm)	123.3 ± 20.4	124.7 ± 25.2	n.s.	127.6
ソフトボール投げ (m)	9.9 ± 4.2	10.4 ± 5.3	n.s.	10.8

(*p<0.05, **p<0.01)

4. 考察

まず、例年と同様に形態データのうち身長、体重、大腿長は安定して有意に増加しており、自然成長が確認された。そして、プロジェクト最終年度にしてついに大腿前部筋厚の有意な増加が認められた(表 1)。過去 2 年間、大腿前部筋厚に有意な変化は認められなかった。これについては第 2 期[2]に「6 歳から 9 歳の小学校低学年期においては大腿前部に短軸（筋厚）の変化は生じにくく、長軸（大腿長）の変化に追いつくような形で筋量が増加している」と考察してきた。つまり、筋厚が減少せずに維持されたという現象をもとに大腿長の増加分だけ体積が増加していたと考えた。しかしながら、3 年目の今回は大腿前部筋厚が有意に増加したのである。ここにきて、プログラムを修正したわけでもなく、回数を増加させたわけでもない中で筋厚が増加した要因について考えられるとするならば、それは「参加年数」ごとの比較がなされるべきであると考えた。そもそも、今回の体力データは第 3 期にしては増加が芳しくなかった（表 2)。介入前後で記録が有意に向上したのは 8 種目中 3 種目（上体起こし、50m 走（$p<0.05$)、反復横とび（$p<0.01$))にとどまった。全ての測定項目について有意に記録向上した第 2 期からみると若干物足りなささえあった。このことについて、集団の特徴に注目してみると、介入前体力データは昨年度よりも今年度の方が 8 種目中 6 種目で高い記録を示していた。これはつまり、集団がすでにある程度高い体力レベルにあることを示している。事実、8 種目中 4 種目については令和 4 年度の全国平均値よりも高い記録であった。それもそのはず、半数は「かみしほろ のびのびキッズ！」に参加し続けている子どもたちなのである。

上記のことから、「初参加群 12 名」とプロジェクト 1 期以上に参加した「リピート群 12 名」に分けてデータを再検討した（表 3)。まず、両群とも身長・体重・大腿長の自然成長が確認された。そして、群別にみると初参加群は筋厚データに変化がなく、リピート群は全ての筋

表 3. 初参加群とリピート群の介入前後比較

測定項目	初参加群 (n=12)	リピート群 (n=12)
身長 (cm)	**	**
体重 (kg)	**	**
大腿長 (cm)	**	**
大腿周囲径 (cm)	n.s.	**
大腿直筋厚 (mm)	n.s.	**
大腿直筋＋中間広筋厚 (mm)	n.s.	**
中間広筋厚 (mm)	n.s.	**
握力 (kg)	n.s.	n.s.
上体起こし (回)	**	n.s.
長座体前屈 (cm)	n.s.	n.s.
反復横とび (回)	**	n.s.
20mシャトルラン (回)	n.s.	*
50m走 (秒)	*	n.s.
立幅とび (cm)	n.s.	n.s.
ソフトボール投げ (m)	n.s.	n.s.

(*$p<0.05$, **$p<0.01$)

厚データが有意に増加していた。つまり、全体として見た時に増加していた筋厚データはリピート群の増加によるものであったことが確認されたのである。リピート群は筋厚こそ増加したものの、体力データは20mシャトルランのみが増加し、それ以外の測定項目については変化しなかった。これは以前から述べているように、体力測定値は神経系の適応が記録改善に影響しやすいため、神経系の適応が済んだ状態、いわゆる「運動に慣れた状態」では体力測定値は伸びにくい。体力データについて、初参加群の記録が向上した種目は、全体の傾向と一致していた(上体起こし、反復横とび($p<0.01$)、50m走($p<0.05$))。筋厚が増加したのはリピート群であり、体力が向上したのは初参加群であったことは、本プログラムは体力測定値改善に対しては即効性が高く、筋厚に対しては非常に遅く2～3年かかることを示している。成人の筋力トレーニングの場合、効果が現れるのは一般的に3ヶ月からと言われているが、本プログラムは「筋力トレーニング」というほど特化したトレーニングではない上に、対象が小学校低学年期であることから筋肥大は起こりにくい。それでもなお、今回のちくだいKIP運動プログラムを2～3年間実施すると、神経系の適応が済んだ後に筋厚が増加していく可能性が考えられる。

船津らの報告[3]では3歳から8歳までの561名について大腿前部筋厚を測定した結果、年齢が上がるにつれて筋厚は増加していた。これをもとに考えると、本研究第1期と第2期において約9ヶ月から11ヶ月の期間をあけて測定したならば、自然成長によって筋厚が増加していてもおかしくはなかった。これについては以下の二点が考えられる。一点目は第2期で考察した「地域差」である。Fukunaga et al.(1993)は、中高齢者を対象に大腿前部筋厚を測定し、都市部居住者の方が農村部居住者のそれよりも有意に高値を示すことから、生活環境が形態に影響する（都市生活が大腿前部筋厚にプラスの効果を及ぼす）ことを示唆した。船津の報告は北九州市近隣と都市部が対象であり、農村部である本研究よりも大腿前部筋厚が高値である可能性はある。両先行研究間では対象年齢が異なるのでこれ以上の推察はできないが、実際上士幌町の小学生の体力は低い[7]。周辺環境により遊び方や運動・スポーツとの関わり方の違いが、小学生の体力に影響しているとするならば、地方町村・農村部が日常生活を基盤に体力作りをしていくためには都市部とは異なった方法を選択するべきといえよう。二点目は「コロナ禍による遊び方の変化」である。2024年現在時点でコロナ禍以前とほぼ同じ生活環境に戻ったと感じるが、コロナ禍で一旦経験した子どもたちの遊びの選択肢は少なくなることはない。携帯型ゲーム機が市場から消えるほどに拡散され、モバイルゲーム、それに伴う通信型ゲーム、動画配信サイト、SNSなど、コロナ禍でさらに発達したそれらが、今なおさらに子どもたちの中に浸透しているのはいうまでもない。事実、第1期では全体の体力が低く、それが1年で体力向上し、第2期～第3期に初めて参加する者は軒並み体力が低かった。そして、それまで全く変化しなかった大腿前部筋厚が第3期にして、しかもリピーター群のみ増加していたことは、リピーター群の普段の生活の中に運動がより多く取り入れられた結果と考えてもよいだろう。身体形態に変化を促すほどの効果を得るために重要なことは年単位での「継続」ということに他ならない。

これからの地方における子どもたちの体力向上において、いくつかの明確な留意事項が確認できたと感じている。一つ目は都市部との生活環境の差異を考慮するということである。先行研究[3]によると、都市部では小学校低学年期においても年齢に伴って大腿前部筋厚が増加していくと報告されているが、農村部ではその生活環境の違いから年齢間の差が少ない可能性がある。つまり、都市部では日常生活によって強いられる運動が小学校低学年期から継続され、相応の大腿前部筋厚と体力が身に付いていると考えられる。一方、農村部は自家用車の利用過多により「ドア to ドア」となる場面が多い。二つ目は継続させる（提供者側も「継続する」）ことの重要性である。継続はもっとも重要でもっとも難しいと感じるが、「かみしほろ のびのびキッズ！」は、器械運動のような成功・非成功がわかりやすく個別目標を立てられる種目を軸に、地元スポーツ少年団との連携で他種目を実

践することによって、個々の自己効力感を高めつつ、なるべく飽きさせない配慮で継続を促した。継続の先には、小学1年生から3年生という若齢期でも筋肥大が生じる可能性が確認された。ただし、生活環境の変化から筋肥大を期待するには中長期的な視点が欠かせない。これらのことから、地方で小学校低学年期の体力向上プログラムを実践する際には、まずは体力と形態レベルは都市部のそれより低い状態にあり、筋力・筋量の増加を促していくことを考えなくてはならない。その際には、結局継続させることが重要であるため、飽きさせないことを重視しつつ、他人との比較ではなく自己の目標を設定しやすいプログラムを作成することが望ましい。

地方における子どもの体力向上コミュニティの育成的運営には、適切な人材と資金が必要不可欠である。自治体にとってそのようなコミュニティの自走化は財源的な課題解決としても理想の形である。基本的には受益者負担が適用されることは時代的にも避けられないが、地方ならではの格差も地域によっては存在するであろう。家庭の条件に合わせて行政からサポートがあることは、格差是正の観点でも、才能の埋没防止の観点でも必要である。これからの時代、部活動地域移行の影響を受けて子どもたちが課外で運動に触れる機会が減少することも考えられる。体力向上コミュニティが地域で存在感のある「子どもの健康セーフティネット」となれば社会的インパクトも高く、SIB（Social Impact Bond）の仕組みを用いた投資対象ともなり得る。

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Abstract

The purpose of this study was to investigate the effectiveness of 8-months special exercise program of Chikudai-KIP the morphological and physical fitness data of children who lives in Kamishihoro Town. And second purpose was to comprehensively review the 1st to 3rd phases and present a long-term vision for the nurturing management of children's fitness improvement communities in rural areas. The subjects included 24 children aged 6~9years participated in this project. Height, weight, thigh length, thigh circumference, and anterior thigh muscle thickness as morphological data, and “the New physical fitness test” as physical fitness data were measured before and after the intervention. The program incorporated the gymnastics class from the previous year, as well as stretching, basic strength training, and progressive exercises for running, jumping,

and throwing before and after the main sessions. In addition, about once a month, “the Kamishihoro Sports Shonen-dan” held various sports experience sessions. The morphological data, height, weight, thigh length, and thickness of rectus femoris muscle (RF), RF + vastus intermedius muscle (VI), VI increased significantly before and after the intervention ($p<0.01$). The physical fitness data, Sit-ups, 50-meter dash ($p<0.05$), and side-to-side jumps ($p<0.01$) improved significantly. Since there was no change in the anterior thigh muscle thickness before and after the intervention during the 1st and 2nd phases, but there was a change only in the 3rd phase, we attempted to compare 12 subjects who were first-time to the program (first-time group) with 12 subjects who had previously participated (repeat group). As a result, muscle thickness increased only in the repeat group, but not in the first-time group. The program has shown to have an immediate effect on improving physical fitness measurements and a very slow effect on muscle thickness, which takes two to three years. The importance of considering the differences in living environment from urban areas and the importance of continuity in improving children's physical fitness in rural areas in the future was confirmed.

Keywords: children, physical fitness, gymnastics

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Fostering Writing Excellence: Learning from University of Helsinki and University of Iceland to Expand Writing Centers in Japanese Universities

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優れたライティング能力を育成する：ヘルシンキ大学、アイスランド大学に学ぶ、日本の大学におけるライティングセンターの発展

寺内　麻紀

Abstract

This study explores the development and enhancement of writing centers in Japanese universities by drawing insights from global models established at the University of Helsinki and the University of Iceland. Despite facing challenges, writing centers play a vital role in fostering writing proficiency and academic success. By analyzing the structures and practices of these centers conducted via interviews and on-site visits, this research aims to identify strategies for increasing the presence and effectiveness of writing centers in Japanese higher education. Through a comparative examination of writing center models in diverse contexts, including those in non-English-speaking countries, this study seeks to provide valuable insights into addressing common obstacles and adapting best practices to the Japanese academic landscape. By leveraging lessons learned from global models, Japanese universities can strengthen their writing centers, thereby better supporting student academic achievement and scholarly contributions on an international scale. This project is funded by the Japan Society for the Promotion of Science, Research-in-Aids for Scientific Research, 23K18896.

Keywords：Writing Center, academic writing, ESL writers, comparison of European model

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Introduction

Writing is widely acknowledged as one of the most effective means of communication, however, sometimes it could lead to misunderstanding or failure to convey intended messages with clarity. Achieving precision, clarity, and logical thinking in expression presents a formidable challenge requiring practice and diligence. Particularly within academic fields, proficient writing is one of the most important aspects of scholarly existence. Numerous researchers and scholars struggle to write their efforts, to publish and to be acknowledged by the wider community. Without proficient composition skills, the accomplishments of their endeavors could remain without recognition and comprehension.

In numerous Japanese universities, the emphasis on writing skills is not as pronounced as in North America and Europe. It is commonly assumed that acquiring the requisite writing skills naturally occurs through engagement with other academic disciplines (McCarthy 2021). A very small percentage of high schools provide the instruction of the structure for academic essay writing (McCarthy 2021). It is assumed that most students are prepared to write an academic paper without particular training or instruction in university courses. The lack of writing instruction in university programs indicates such an assumption.

Another aspect worth considering is the challenges of writing in English. Within the academic realm, proficient English writing is indispensable for accessing resources, fostering collaboration, advancing careers, and contributing to the global dissemination of knowledge and research findings (Kaufhold & Yencken 2021; Sheehy 2023). Hence, the teaching of English writing holds significant importance in Japanese universities, paralleling the acquisition of English conversation skills (Yamamura & Nakatake 2023). Given that English serves as a second language for the majority of Japanese students, explicit instruction becomes imperative for academic success. However, some individuals view English writing as unnecessary due to their immersion in a predominantly Japanese-speaking environment, failing to recognize its essentiality beyond daily communication (Yamamura & Nakatake 2023). Moreover, others perceive it as an unattainable skill, citing language barriers and limited exposure to English-language environments (Sheehy 2023). Consequently, such perceptions may deter individuals from seizing opportunities for personal and professional growth afforded by proficiency in English writing.

Effective writing, particularly in English, is imperative for student academic and professional success. However, in Japan, the presence of active writing centers (WCs) within universities remains limited (Yamamura & Nakatake 2023), leaving students without adequate support in honing their writing skills. Recognizing the critical role of English writing proficiency, it is imperative for Japanese universities, including my own, to establish robust WCs. These centers would provide essential institutional support, offering guidance, resources, and workshops aimed at enhancing student writing abilities (Kobayashi & Nakatake 2019). By investing in WCs, universities can empower students to navigate the complexities of academic writing in English and equip them with the necessary skills to excel in a globalized world. Such initiatives not only foster academic excellence, but also contribute to the broader goal of nurturing well-rounded, proficient communicators prepared for the demands of the modern workforce.

History of WC

The history of WCs traces back to the early 20th century in the United States (US) (Carino 1995, 1996). Initially they were called writing labs or clinics and conceived as remedial courses catering to individuals requiring personalized writing instruction. However, soon these centers evolved into crucial resources supporting students with diverse writing needs in higher education (Carino 1995, 1996). Presently, WCs are ubiquitous across the US and Canada (Sheehy 2023),

and their model has been adapted in numerous countries worldwide. While WCs may not be as prevalent in Australia and New Zealand, many universities offer alternative forms of academic support, including writing assistance. In Japan, although few in number (MEXT 2022), WCs have emerged over the past two decades, mirroring the American model and providing valuable support to students navigating the complexities of academic writing.

Defining WC

The composition of a WC encompasses a spectrum of variables, including size, organizational layout, and staffing configuration (Burke 2020; Harris 1985). These centers can vary widely, ranging from modest operations with minimal personnel to larger entities with multiple staff members fulfilling diverse roles. For instance, some centers may consist solely of a director who assumes various responsibilities, while others may comprise a director, teachers, administrative staff, and numerous student tutors attending to a substantial volume of student inquiries daily. These centers may find their placement within academic departments, such as libraries or language departments, or they may function independently with their own distinct departments (Harris 1985). In certain cases, a WC may operate autonomously under the supervision of a director who manages a team of permanent staff members and student tutors within a dedicated physical space. Conversely, WCs may also be affiliated with libraries or student advising services, broadening their support network within the academic community. Consequently, the size and structure of a WC are contingent upon the unique needs and resources of the institution or student body it serves (Harris 1985).

Furthermore, the support provided by WCs extends far beyond the confines of traditional academic research paper writing. While many may associate academic writing solely with research papers, the spectrum of academic writing encompasses a much broader array of tasks. For instance, WCs often offer assistance in refining research skills and practicing presentations (Hughes 2023). Academic writing encompasses various formats, including text for presentation slides and crafting resumes for internship applications. Additionally, students may seek guidance for assignments requiring short opinion paragraphs or other forms of writing within their coursework. Therefore, the support offered by WCs is not limited to research papers or theses, but extends to meet the diverse writing needs of students across various academic contexts.

Moreover, the scope of recipients for WC services is broad and diverse, reflecting the varied demographics and needs within educational institutions (Harris 1985). While the primary recipients are typically current students, some WCs extend their services to faculty and administrative staff. Additionally, international students, professionals in business settings, and graduate students are among those who may seek assistance from WCs (Kaufhold & Yencken 2021). This inclusive approach ensures that individuals from a wide range of backgrounds and academic disciplines have access to the support and resources necessary to enhance their writing skills and achieve their academic and professional goals (Herzl-Betz et al. 2023; Mendoza et al. 2022).

Ideal to reality

Another challenging aspect in defining a WC lies in the disjunction between the idealized visions held by individuals and the practical realities they confront. Scholars often articulate their idealized concepts of a perfect WC in conference presentations and publications (Harris 1985). However, the actual operational landscape of WCs frequently entails constraints such as limited resources and fluctuating governance structures (Franklin 2019; Yamamura & Nakatake 2023). Consequently, reconciling these idealized visions with the pragmatic constraints of real-world implementation can prove challenging. This dissonance between vision and reality complicates efforts to develop a comprehensive

understanding of what constitutes a WC.

Evolution

Another aspect that complicates defining WCs is their inherent tendency to evolve (Harris 1985). The demands of students and institutions can shift over time. For instance, English major tutors initially tasked with aiding psychology students may need to adapt their support strategies accordingly. Budgetary constraints may fluctuate, leading to potential reductions in the number of available tutors compared to previous years (Kobayashi & Nakatake 2019). Additionally, staff turnover is common, resulting in a lack of permanent personnel within the center. Student tutors graduate and move on, further contributing to this dynamic environment. Moreover, WCs must continually evolve to respond to external influences such as technological advancements and global events like the COVID-19 pandemic. This recent crisis underscored the necessity for flexibility and innovation, demonstrating that once change occurs, reverting to previous states is often impossible. Changes are always being required in WCs whether at the personal or structural level.

Defining some key aspects of WCs

Although defining the WC presents challenges (Harris 1985; Hughes 2023), several common key features can be identified. By delineating these aspects, I aim to use them as benchmarks when comparing WCs worldwide. The selection of these key features was informed by consultations with Dr. Joseph Franklin, the director of the WC at New York City College of Technology, and an analysis of the first 20 American universities generated through the search term “writing center." Dr. Franklin, holding a doctoral degree in English (Composition and Rhetoric) from the US, boasts extensive experience in WCs in both the United Kingdom (Franklin 2019) and the US, in addition to his current directorial role. His expertise encompasses a comprehensive understanding of Amerian WCs and their distinctions from those in other countries. Furthermore, a Google search using the term "writing center" yielded the first 20 American schools, indicating their active status and popularity among users. Therefore, these institutions can be presumed to represent currently active WCs in the US.

Writing support

While the fundamental purpose of a WC is to provide writing support, the specific types of writing assistance offered may vary from one center to another. Common areas of support include assistance with homework essays, class assignments, research papers, and dissertations. Additionally, some centers extend their services to include help with crafting presentation slides and posters for classes or conferences. Furthermore, WCs may offer guidance on writing grant proposals, fellowship applications, graduate school admissions essays, job applications, or other forms of academic and professional writing.

It is important to note that most WCs explicitly state that they do not provide editing services. Despite the common misconception that bringing in a rough draft will result in a polished finished product, the primary aim of WCs is to empower students to become better writers themselves. Rather than editing students' writing, WCs focus on teaching individuals how to edit their own work, fostering self-reliance and improving writing skills in the process.

One-to-one consultation

Most WCs offer one-to-one consultations, typically involving a tutor and a tutee, both students collaborating at a table (Sheehy 2023). Many centers also provide drop-in hours, allowing students to casually seek writing consultations if staff is available. Additionally, students have the option to schedule appointments in advance to guarantee

support. The duration of these one-to-one consultations varies, ranging from 20 minutes to 1 hour.

Students tutors

One of the popular models of WCs involves employing student tutors (Harris 1985; Sheehy 2023), typically senior undergraduate or graduate students, who undergo a series of training sessions to become proficient tutors. Once trained, these tutors are assigned to provide one-to-one consultations for students seeking writing assistance. This position is often paid, making it an attractive work opportunity for tutors and providing valuable work experience.

Recruitment methods for student tutors vary among institutions. Some institutions require completion of a specific English course, while others rely on recommendations from teachers or current WC staff. Additionally, some institutions advertise open positions, allowing interested students to apply for the role.

Despite potential obstacles in training and recruitment, there are several common benefits to being a student tutor. Many tutors are working towards careers as teachers or researchers, making the teaching experience gained in the WC valuable for future teacher candidates. Furthermore, exposure to various types of writing benefits future researchers who will need strong writing skills in their academic pursuits.

Physical space

WCs typically offer physical space where tutors and students can collaborate on their writing projects. They have a reception area to welcome students in need and provide instruction on how the WC operates. These spaces are equipped with desks and chairs to facilitate productive sessions. However, in some cases, WCs primarily operate online and may not have physical locations. Whether physical or virtual, WCs aim to create an environment conducive to effective writing consultations and support.

Workshops

Many WCs offer workshops aimed at providing a broad understanding of academic writing to a large number of students (Hughes 2023). These workshops often include introductory sessions tailored for freshmen who are new to university-level writing. Additionally, some WCs collaborate with lecturers to deliver embedded workshops within specific courses. By working closely with course instructors, WCs can tailor their workshops to address the specific writing challenges and requirements of individual courses. These workshops serve as valuable resources for students, helping them develop essential writing skills necessary for academic success.

Messaging

Most WCs have systems in place to engage with the wider school community. Typically, they maintain a website detailing their functions, location, and operating hours. Additionally, they offer writing resources covering citation guidelines, writing style, and tips for academic writing, which serve as references for anyone seeking assistance. Many WCs have also embraced social media platforms such as Facebook, Instagram, and X (formerly Twitter) to announce events and share daily activities. They often organize class visits, particularly targeting first-year courses, to introduce their services and provide guidance on accessing them, or invite students to visit the center in person for a firsthand experience. Posters displayed on noticeboards and other prominent locations frequented by students are commonplace, along with signage directing students to the center for easy access.

On-site visits to University of Helsinki (UH) and University of Iceland (UI)

After the Covid pandemic, travel restrictions were lifted,

ushering in a return to unrestricted travel reminiscent of pre-pandemic times. The EuroCALL2023 conference, originally postponed for three years due to online constraints, finally took place in Iceland as initially planned. Taking advantage of this opportunity, I presented at the conference, which coincided with my visit to the University of Iceland (UI).

Ms. Emma Björg Eyjólfsdóttir, the director of the Center for Writing (WC) at UI, kindly accepted my request to visit. Given the breadth of topics to discuss regarding WCs, we decided to divide our meeting into several sessions rather than attempting to cover everything in a single day.

Since there are no direct flights to Iceland, I chose to stopover in Helsinki, home to the University of Helsinki (UH). Notably, this university boasts a renowned agriculture and veterinary medicine faculty, aligning closely with the academic disciplines at my own university, Obihiro University of Agriculture and Veterinary Medicine. Fortunately, Dr. Tuula Lehtonen, a senior lecturer at the Language Center at UH, graciously accommodated my request to visit her Language Center, recognizing the shared interests in our research.

English as second language

In Finland, a significant majority of master's students, around 81%, opt to write their theses in English (Mendoza et al. 2022). Despite primarily identifying Finnish as their mother tongue, with some also reporting Swedish and other languages, most find themselves composing their academic works in their second language. This trend is not exclusive to the UH, but is prevalent across various universities in Finland, all actively embracing internationalization efforts (Mendoza et al. 2022). These institutions emphasize the cultivation of robust academic and communication skills in English to facilitate effective participation in global academic discourse (University of Helsinki 2024). Dr. Lehtonen, recognizing the imperative of English communication within her institution, underscores the necessity for English writing skills among students, despite it not being their first language.

In Iceland, the prevalence of English is on the rise (Þórarinsdóttir 2011), although the official language is Icelandic. English has become deeply integrated into both the educational system and the business environment. English proficiency is cultivated from a young age across all generations, contributing to its widespread use. At the UI, the Center for Writing plays a pivotal role in supporting students, staff, and faculty members. The center acknowledges the importance of proficiency in both Icelandic and English and offers support for both languages. Additionally, Director Eyjólfsdóttir emphasizes the importance of providing support for international students as well.

In both Finland and Iceland, there exists a pressing need to utilize English within the academic community. Similar to the situation in Japan, where the use of Japanese is predominantly confined within the country, scholars in Finland and Iceland must resort to English when seeking publication beyond their national borders. As such, proficiency in English is indispensable for academic success in an increasingly globalized academic landscape.

Similarities with University of Helsinki

The UH Language Center recognizes the paramount importance of writing, particularly in English, and underscores the significance of academic writing. The Language Center, as highlighted on their website, plays a key role in supporting students, especially those for whom English is a second language, which is the majority of their students. Moreover, in our interview, Dr. Lehtonen acknowledged the disparity between academic and non-academic writing, emphasizing the necessity for academic writing to be taught as a distinct discipline, separate from regular English courses. She also concurs with the notion that the WC or other forms that support writing should not serve merely as an editing and proofreading facility, but rather as a resource to aid students in enhancing their own writing skills.

A shared characteristic with the Language Center at the UH is the provision of one-to-one consultations. These consultations primarily cater to graduate students who are tasked with composing their Master's or Doctoral dissertations in English. At the Language Center, the responsibility of tutoring is collectively undertaken by a group of teachers. Upon student request, appointments can be scheduled with a tutor, who is a teacher at the Language Center.

Amidst the pandemic, the efficacy of online one-to-one sessions became evident, particularly in the seamless sharing of students' writing pieces on-screen. Consequently, even post-pandemic, the university continues to utilize online platforms, a trend observed in numerous other institutions. While online consultations remain popular among students and sometimes teachers, the university now reinstates face-to-face or blended consultations following the pandemic.

Echoing the practices of many other WCs, the UH offers English courses and workshops. Specifically tailored for Master course students, "Academic Writing for Master's Students 1" and "Academic Writing for Master's Students 2" are designed to equip students with the skills necessary for their thesis writing endeavors. These courses serve as preparation for Master's theses, albeit their requirement varies depending on individual programs. Furthermore, the Language Center extends its offerings with "Feedback on Writing" catering to students interested in providing and receiving feedback on their writing abilities.

Like most WCs worldwide, the Language Center offers English writing support through its website. Here, visitors can find a detailed list of English academic writing courses, as well as information on available peer support for thesis writing. Additionally, the website offers links to valuable resources for academic writing, encompassing citation references and online editing tools. These resources empower students to self-edit their writing effectively.

Similarities with University of Iceland

The principles of the WC are also upheld in Iceland. Although the WC at the UI may be modest in size, it boasts a designated director, Director Eyjólfsdóttir, who is wholly committed to providing support for students' writing needs and overseeing related activities. Director Eyjólfsdóttir, the director of the WC, emphasizes that teaching writing skills rather than simply editing student work is paramount within the center. She acknowledges the distinction between academic and non-academic writing, recognizing the significance of writing skills for professional development. Thus, the center prioritizes fostering strong academic writing practices akin to those in the US.

One-to-one support from student tutors is a prominent feature of the WC at the UI, regarded as one of its key components. This service extends beyond students to encompass the entire school community. Student tutors primarily assist fellow students, while the director offers guidance to faculty members and administrative staff.

Adopting a student-tutor model akin to the American approach, the Center for Writing recruits student tutors to collaborate with their peers. While recruitment primarily occurs through open advertisements, the director may also extend invitations to potential candidates. Additionally, experienced tutors play a pivotal role in encouraging interested individuals to apply for positions within the center.

Similar to many other centers, the WC in Iceland is situated within the library, a hub frequented by students seeking resources for their studies. A welcoming reception area invites students to schedule appointments or seek consultations, and dedicated spaces are provided for tutoring sessions.

Furthermore, the Center for Writing at the UI offers an array of workshops, writing groups, in-class instructions, and peer tutoring sessions (Stúdentablaðið 2021). Workshops, typically lasting an hour, cover various aspects of academic English and are available throughout the year for writers of

all levels. Topics range from utilizing EndNote software to mastering proper source citation techniques in both text and reference lists. Additionally, specialized workshops cater to the needs of graduate students.

In-class instructions involve collaboration between the director and lecturers to tailor writing assignments within specific subjects. These sessions encompass introductions to the WC, guidance on poster presentations, and practical instruction on utilizing Microsoft Word (Stúdentablaðið 2021).

Their approach to engaging with the school community mirrors that of mainstream WCs. Workshops and practical writing resources are readily accessible on their website, providing valuable support to students. Moreover, the Center for Writing maintains an active Facebook page, regularly updating it with news about tutors and upcoming events to showcase the center's offerings. In-class instructions serve as another avenue for reaching out to students who may not be aware of the center's existence, further enhancing its outreach efforts.

Differences of UH

The UH does not have a designated "WC," but rather integrates writing support within the Language Center, where English teachers share the responsibility of assisting students with their writing needs. Given that the majority of students in the international Master's programmes are non-native English speakers, there is no system of student tutors or peer support. Instead, a group of English teachers within the faculty take on the task of providing writing support. While most undergraduate students write their theses in Finnish or Swedish, many graduate students write theirs in English. Consequently, the majority of students who seek academic writing assistance from the Language Center are graduate students.

Due to space constraints and associated costs, the university does not have physical tutoring spaces available. Located in downtown Helsinki, the UH faces limitations in building space. Each faculty has classrooms and offices at their disposal, but they are required to cover rent expenses from their budgets. Thus, to save money as well as the convinience of screen sharing, one-on-one consultations are conducted via Zoom meetings. This transition occurred during the 2020 pandemic, and even post-pandemic, many find it more convenient to collaborate on papers using individual screens rather than sharing physical documents.

In contrast to many WCs that offer a range of writing support services from class assignments to job applications for both undergraduate and graduate students, the demographic seeking help at UH primarily comprises graduate students working on their master's or doctoral dissertations. While some undergraduates are enrolled in English programs and thus more likely to seek writing support, the majority of students are graduate students.

Another notable aspect of UH is the worry about the fate of the national languages. While many teachers and students recognize the importance of English writing, there occasionally is opposition to English writing due to perceived threats to the Finnish language. Additionally, Finland has two official languages, Finnish and Swedish, and some individuals feel a strong attachment to producing Finnish writing to preserve tradition. Consequently, there is, at times, resistance to writing in English at the university, with efforts made to encourage students to write in their native language, Finnish.

Differences of UI

One notable distinction at the UI lies in its provision of language support for non-native speakers. The university offers English assistance for both Icelandic and non-English native speakers, along with Icelandic language support for non-Icelandic speakers. This initiative stems from a growing concern regarding the decline in Icelandic speakers nationwide, underlining the importance of nurturing Icelandic

literacy. Director Eyjólfsdóttir also acknowledges the trend of English being increasingly favored over Icelandic in daily communication. However, she emphasizes the imperative of supporting both languages, recognizing the ubiquitous need for English writing skills while ensuring the preservation of Icelandic language proficiency.

Discussion

Need for WCs in Japan

In March 2024, the Ministry of Education, Culture, Sports, Science, and Technology (MEXT) unveiled its plan to triple the number of PhD holders by 2040 (MEXT 2024). The Japanese government perceives a pressing need for a greater number of PhD holders to enhance the country's competitiveness on the global stage. Proficiency in English is deemed essential for successfully completing a PhD, regardless of the research field. English serves as the dominant language of publication in many academic disciplines, necessitating the ability to read, write, and communicate effectively in English for research purposes.

Writing in English poses obstacles, particularly in Japan, where it serves as a second language for many. English education in Japanese high schools often prioritizes test-taking strategies over practical speaking and writing skills (McCarthy 2021). There is minimal emphasis on generating meaningful output, with the focus primarily on sentence-level translation exercises from Japanese to English. Consequently, most students arrive at college unprepared to compose coherent paragraphs (McCarthy 2021). This reality underscores the critical need for WCs at universities.

Academic writing often receives insufficient attention despite its inherent challenges (Margolin et al. 2013). It is inherently complex, especially when aiming to publish in international journals. Even native English speakers find articulating findings, methodologies, and conclusions in a clear manner demanding (Margolin et al. 2013). Furthermore, organizing ideas logically throughout the paper, crafting engaging introductions and conclusions, and structuring arguments effectively are just some of the examples of the difficulties of academic writing. Consequently, academic writing demands a focused approach and should be treated as a distinct skill cultivated within the university or higher educational institution setting. WCs offer invaluable support for individuals seeking to enhance their academic writing proficiency (Kobayashi & Nakatake 2019).

Recognizing the difficulty of academic writing can motivate individuals to actively pursue the acquisition of this complex skill. Establishing WCs helps bring attention to the nuances of academic writing, encouraging students and scholars to prioritize mastering writing styles and conventions. By fostering a culture that values effective academic writing, WCs mitigate the risk of research articles being rejected solely due to issues with writing style. Through targeted support and resources, WCs empower individuals to enhance their writing proficiency, thereby bolstering the quality and impact of their scholarly contributions.

Application from UH and UI

One crucial consideration in Japanese universities is that the majority of students, for whom English is not their first language, need a tailored approach to WC practices, as the direct application of the American model may not be suitable. Despite limited research on English as a Second Language (ESL) students at WCs (Williams 2004), it is widely acknowledged that the non-directive tutoring model may not effectively address the needs of ESL learners. Unlike native English speakers, L2 learners may lack the linguistic knowledge necessary to fully engage in non-directive tutoring sessions, potentially leading to frustration for both the tutor and the student (Kaufhold & Yencken 2021).

ESL students often encounter challenges in producing comprehensible sentences in their non-native language. In these instances, it is common for students to seek assistance

with grammar and wording, even if WC policies discourage direct correction. Consequently, there is a need to adapt the standard WC model to better accommodate the needs of the local demographic (Sheehy 2023). This may entail incorporating more directive approaches to tutoring or providing additional resources specifically tailored to ESL students. By recognizing and addressing these unique challenges, WCs can better support ESL learners in their academic writing endeavors (Sheehy 2023).

Examining the WCs of Finland and Iceland holds significant value due to their shared status as non-English native countries, similar to Japan. Dr. Lehtonen's research on WCs in the US underscores the recognition that the American or English native speaker model may not directly translate to non-English speaking nations. Despite possessing higher average levels of English proficiency compared to Japan, both Finland and Iceland grapple with language barriers alongside academic writing challenges. For instance, the UH faces limitations in hiring student tutors due to insufficient English proficiency among potential candidates, which impedes their ability to provide peer support effectively. The Center for Writing at UI employs student tutors; however, the director mentioned the challenges of finding suitable candicates due to their native language not being in English.

The UH serves as an exemplary model of a WC that does not necessarily require physical space. Given the space constraints faced by many universities in Japan, exploring alternatives such as online platforms or borrowed spaces can effectively support student academic success. Moreover, targeted support for specific student demographics, such as graduate students, can significantly enhance the effectiveness of WC services when a small number of staff is attending the one-to-one consultation. For instance, dedicating resources to support doctoral students, as demonstrated by the UH, can greatly increase their success in completing their dissertations (Mendoza et al. 2022).

Like many Japanese universities, the UH and the UI also encounter challenges in finding suitable tutors. However, they have implemented strategies to overcome this obstacle. In the UH's Language Center, English teachers collaborate to provide support to students, demonstrating their dedication to student success beyond their classroom duties. Similarly, the UI's WC director carefully selects potential tutors and offers competitive wages to attract candidates, highlighting the importance of teacher commitment and strategic recruitment in addressing tutor shortages. By fostering a culture of support and collaboration among teachers, universities can effectively overcome challenges in providing WC services to students.

Conclusion

Despite the challenges they face, WCs remain vital spaces for fostering writing proficiency and promoting academic success. As they continue to evolve and innovate, they play a crucial role in supporting students on their journey to becoming confident and effective communicators. Regardless of their size or structure, WCs should always be accessible to those in need within a university community.

While the number of WCs in Japanese universities may be limited, they still represent valuable resources for students. In future studies, it would be beneficial to examine these existing centers in Japan using the standard American model, as well as drawing insights from examples in Helsinki and Iceland. By analyzing Japanese university WCs, we can gain a clearer understanding of the trends and common obstacles faced by Japanese students. Through studying various examples, universities of all sizes can learn from existing models and establish their own WCs. This approach can better support student success in academic endeavors while providing scholars with the necessary resources to share their ideas on a global scale.

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Additionally, I extend my appreciation to Dr. Joseph Franklin at New York City College of Technology for his time and expertise during the Zoom interview and subsequent consultations, which significantly contributed to the development of this research.

Their generosity and expertise have been instrumental in shaping the direction and depth of our study.

概要

本研究は、ヘルシンキ大学やアイスランド大学で確立された世界的なモデルから示唆を得ることで、日本の大学におけるライティング・センターの発展と強化を探る。ライティング・センターは課題に直面しながらも、執筆能力の育成と学問的成功のために重要な役割を果たしている。本研究では、ライティング・センターの構造や実践をインタビューや現地訪問を通じて分析することで、日本の高等教育におけるライティング・センターの存在感と効果を高めるための戦略を明らかにすることを目的とする。非英語圏を含む多様な状況におけるライティング・センター・モデルの比較検討を通じて、本研究は、共通の問題を考察することにより、日本の大学の状況に適応させるための貴重な洞察を提供することを目指す。世界的なモデルから学んだ教訓を活用することで、日本の大学のライティング・センターを設置、または強化することができ、それによって国際的な規模で学生の学業達成と学術的貢献をより支援することができる。本研究

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キーワード：ライティングセンター、アカデミックライティング、ESL ライター、欧州モデルの比較

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Acceptance of Augmented Reality App among Museum Professionals Case of Vilnius City Museums

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博物館専門職員による拡張現実アプリの受容
ヴィリニュス市立博物館の事例研究

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Abstract

In the late 2010s, augmented reality (AR) smartphone applications were a global trend in museums. Previous studies on attempts to implement AR apps were mainly examined for the benefits to visitors, but one aspect was lacking: how do museum professionals accept them? This study explores the question in the case of the AR app "Daugiau nei matai (hereafter 'DNM')" at four museums under the Vilnius Memorial Museum Directorate in Lithuania's Vilnius City Municipality. The study conducted a comprehensive questionnaire survey of all ten museum professionals involved in the app's implementation, and a short interview with the app developer. The survey results were analyzed from four perspectives including basic usage and impressions, values of DNM, role of museum professionals in development, and advantages/disadvantages. As a result, it was found that museum professionals positively utilize the AR app when they are convinced of its value to visitors.

Keywords: Museum, augmented reality, Lithuania, museum education

Introduction: Augmented Reality in Context of Museum Studies

The use of information and communication technologies in museums has been a dominant and growing topic in museum studies over the last couple of decades. This usage has a global trend that is dependent on technological innovation and other factors. In the late 2010s, augmented reality (AR) smartphone applications were the trend, due to the rapid dissemination of smartphones worldwide[2]. This paper explores the question, "How do museum professionals accept augmented reality guidance for visitors?". The author

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conducted a case study in 2018 on Vilnius City Museum, which released the smartphone app, "Daugiau nei matai (hereafter 'DNM')", in 2017.

Augmented reality (AR) is a technology that adds digital content by overlapping it with the real world, which is displayed on smartphones or other specific equipment. More specifically, Schueffel (2017:2) defined AR as,

> An enhanced version of physical real-world reality, in which elements are superimposed by computer-generated or extracted real-world sensory inputs such as sound, video, graphics, or haptics.

The first idea emerged in the late 1960s, and its usage has broadened, including in the military, space science, and entertainment, since the end of the last century (Schmalstieg and Hollerer 2016).

AR has become popular because of the widespread use of smartphones. Museums have also started to develop smartphone AR apps for visitor guidance in the Tokyo National Museum, National Museum of Singapore, and National Museum of Natural History in the United States (Tokyo National Museum n.d.; National Museum of Singapore n.d.; Smithsonian National Museum of Natural History n.d.). Apps are downloadable for individual smartphones; therefore, museums no longer have to lend visitor equipment.

Previous research related to AR apps has two perspectives: technology- and visitor-oriented. Technology-oriented studies have aimed to develop an AR system for museums or prototypes to solve the challenges of existing systems. For instance, Kim and Park (2011) proposed an attempt to improve the limitations of sensors, and Wang (2018) sought to strengthen the indoor positioning and recommendation functions.

On the other hand, visitor-oriented studies have aimed to improve visitor learning experiences in museums. For example, Yoon and Wang (2014) clarified AR learning in a science museum, and Kyriakou and Hermon (2019) attempted to enhance the experience of children by combining a 3D model and a head-mounted display using AR. Moreover, Tom Dieck and Jung (2017) examined the value of an AR app in museums from various perspectives.

Previous studies have shown that efforts by large national-level museums stand out, and the perspective of how museum professionals use these apps is lacking. Thus, this study focuses on relatively small museums and their attempts to implement AR apps, especially how museum professionals accept them. The author selected an app "DNM" at the Vilnius City Museum in the Republic of Lithuania. Primary data were collected through a questionnaire and short interviews to explore the acceptance of the app by museum professionals.

The remainder of this study is structured as follows. The next section "Background" will briefly explain the case of this study, a smartphone app "DNM" ("more than

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[2] The author originally wrote this paper in 2018, and submitted to an online journal in February 2019. However, the journal ceased publishing new issues in 2019 (as of April 2024, the latest issue was in 2018). She waited her paper's review for five years, and requested the withdrawal of her paper from the journal on April 1st, 2024. On the same day, she received an answer from the editorial department that her withdrawal was accepted. Although, this paper discusses the acceptance of the latest technology by museum professionals, it is still relevant for museum studies in 2024. Thus, the author decided to publish this paper in the *Research Bulletin of Obihiro University*. To adapt this paper to the contemporary research context, the author looked it over and made corrections.

you see," in Lithuanian). The following "Methodology" section will display the data collection method used in this study: a questionnaire and a short interview. Subsequently, the "Finding" section will first show the results of the questionnaire as graphs and the result of the interview as a table. The results were analyzed from four perspectives. Finally, the "Discussion and Conclusion" sections discuss the findings and summarizes the paper.

Background: Smartphone App "Daugiau nei matai"

On November 3, 2017, Venclova's House Museum's YouTube channel posted a short film that promoted the smartphone app "DNM" (Venclovahouse 2017). The film revealed that the DNM is available in four museums: Venclova's House Museum, Vincas Kreves- Mickevicius Memorial Flat Museum, Vincas Mykolaitis-Putinas Memorial Flat Museum, and the Beatrice Grinceviciute Memorial Flat Museum (ibid.). About two weeks later, on November 15, the Faculty of Communication of Vilnius University announced the release of the app on its website (Komunikacijos Fakultetas 2017). As of April 3, 2024, DNM was still available on Google Play Store (Google n.d.). This section briefly summarizes the basic information of the four museums and demonstrates how DNM works.

The four museums listed above are owned by the Municipality of Vilnius City and are all under the Directorate of the Vilnius Memorial Museum (Vilniaus memorialinių muziejų direkcija). Each museum is a memorial of Lithuanian cultural figures, as their titles show, located in the places

Table 1. Four museums under Directorate of Vilnius Memorial Museum

Lithuanian title / English title	Abbreviation	Address
Venclovų namai-muziejus / Venclova's House Museum	V	Pamėnkalnio g. 34, LT-01114 Vilnius
Vinco Krėvės-Mickevičiaus memorialinis butas-muziejus / Vincas Kreves-Mickevicius Memorial Flat Museum	K	Tauro g. 10, Vilnius LT-01114*
V. Mykolaičio-Putino memorialinis butas-muziejus / Vincas Mykolaitis-Putinas Memorial Flat Museum	P	Tauro g. 10, Vilnius LT-01114*
B.Grincevičiūtės memorialinis butas-muziejus "Beatričės namai" / Beatrice Grinceviciute Memorial Flat-Museum	B	A.Vienuolio 12 – 1, Vilnius LT- 01104

* Vincas Kreves-Mickevicius Memorial Flat Museum and Vincas Mykolaitis-Putinas Memorial Flat Museum are placed at the same address, but on different floors and in separate venues.

Table 2. Statistical data of four museums under Directorate of Vilnius Memorial Museum (2017)*

Abbreviation (i.e. Table 1)	Number of staff	Number of exhibits	Number of annual visitors	Area of exhibition halls (m2)
V	2	13136	3301	31.95
K	3	3241	3456	95.8
P	2	5793	3655	41
B	3	2955	2584	29.23

* The statistical data in the chart refer to the official data published by the Ministry of Culture of the Republic of Lithuania. The statistics for Lithuanian museums are downloadable directly from the Ministry's website (Lietuvos Respublikos Kultūros Ministerija 2023).

where the figures lived. Museum details are listed in Tables 1 and 2. As statistical data in Table 2 shows, all four museums are small in terms of workers, space, and collections.

The development of DNM is according to the project "Implementation of technological innovations and their impact study in Vilnius Memorial Museums" (Technologinių inovacijų diegimas ir jų poveikio tyrimas Vilniaus memorialiniuose muziejuose [in Lithuanian]) (Lietuvos nacionalinis dailės muziejus 2017). Paveldo Komunikacija developed the app (Google n.d.). The Faculty of Communication at Vilnius University, which announced DNM's release on its website, provided the technological cooperation for this project.

DNM is provided for free only in Google Play Store. Anyone that has a smartphone that can download the app via Google Play Store can install it on their device (Google n.d.). However, the main function of DNM is for using in the four museums mentioned above. DNM has four functions: augmented reality, instructions, map, and general information. All functions are accessible from the first view of the app (Fig. 1, left).

Augmented reality (Papoldyta realybė)

This is the primary function of DNM. When a user pushes the button on the first view, the smartphone camera starts, and the user can see almost the same view on the display as the user sees it directly, as when one uses a camera app. When the app detects the AR markers, the DNM displays the corresponding digital content. The AR markers in this app are objects in the exhibition room, such as bookshelves or paintings on the walls. The content included photos, manuscripts, 3D objects, and voice and video recordings. The middle and right figures in Fig. 1 show a comparison of a simple photo and the app view at the Vincas Mykolaitis-Putinas Memorial Flat Museum.

Instruction (Instrukcija)

This is a supplementary function of this app, which shows users how to use the app.

Map (Žemėlapis)

This is also a supplementary function of the app, which leads users to the venue. When a user pushes the button, the

*Fig.1 (Left) First view of app (screenshot by author), (Middle) View of app in same venue (screen shot by author), (Right) Photo in Vincas Mykolaitis-Putinas Memorial Flat Museum (photo by author).

* All photographs and screenshots were permitted by Directorate of Vilnius Memorial Museums.

screen is transferred to a map app that shows the location of the four museums.

General information (Apie)

Thus, the function aims to provide users with general information about the four museums. The information includes opening hours, logos, brief descriptions, addresses, email addresses, telephone numbers, and links to Facebook pages.

Methodology

The data collection methods used in this study were a questionnaire and short supplemental interview. The primary aim was to collect data on how museum professionals accepted and worked with DNM. The author conducted the questionnaire with ten museum professionals at the four museums, as shown in Table 1. She directly distributed and collected the printed question lists from August to September 2018. The question list consisted of five sections: general usage of DNM, usage in educational programs, values/ comfort, plans, and roles in development (Table 3). Notably, to examine the value of the app, the author included the five AR values of Diek and Jung (2017). The questionnaire was written in Lithuanian. In further sections, free-description answers written in Lithuanian were translated into English by the author.

Additionally, the author conducted a short interview with a DNM developer at Paveldo Komunikacija to examine the role of museum professionals during the development phase of the app. This interview was intended to clarify the workflow of DNM development and the roles of developers and museum professionals in each stage. The interview was not recorded. The workflow for developing the DNM was formed according to the interview, and the interviewee verified it via email.

Table 3. Question list for Questionnaire Survey

No.	Question	Answer Method
1	General usage	
1-1	How do you usually use DNM, when you guide visitors?	Multiple options 1) I use as the main tool 2) I use as a supplementary tool 3) I don‘t use, but introduce it to visitors 4) I don‘t use nor introduce
1-2	How do you introduce the app to visitors?	Multiple options (Multiple choices allowed) 1) I explain directly to visitors 2) I give a written explanation 3) A written explanation is on the wall 4) Via website or social network service How often? (More than once a week / several times a month / several times since the app release) 5) Other
1-3	What do you explain when you show the app to visitors?	Multiple options 1) Instruction on how to use it 2) About its contents in detail 3) Other

1-4	How often do you see visitors who know about the app in advance?	Multiple options 1) Several times a week or more 2) Several times a month 3) Several times since the app release 4) Never
1-5	How did visitors react to the app? Please explain.	Open ended answer
2	Usage in educational programs	
2-1	Please list current educational programs at your museums.	Open ended answer
2-2	Do you have any educational program which utilizes smartphone or tablet computer? If yes, please list them	Open ended answer
2-3	Do you have any educational program which utilizes the app? If yes, please list them.	Open ended answer
3	Values/comforts	
3-1	What are the advantages of the app for you?	Open ended answer
3-2	What are the disadvantages of the app for you?	Open ended answer
3-3	Did you have any technical problem with the app? If yes, how did you solve it?	Open ended answer
3-4	Which of below are values of the app do you think? Why?	Multiple options (Multiple choices allowed) 1) Economical value 2) Social value 3) Historical and cultural value 4) Educational value 5) Experiential value 6) Othe
4	Plans	
4-1	Do you intend to use the app furthermore?	Multiple options 1) Yes 2) Yes, but it would be better to have something different 3) Other
4-2	When the app become unavailable due to technological reasons, are you going to create new app?	Multiple options 1) Yes, I want something similar 2) Yes, I want something newer 3) No, I don't think I need 4) Other
5	Roles in development Were you involved in the app development? If yes, please answer to questions below.	
5-1	What was your role at development?	Open ended answer
5-2	How did you select the contents for the app?	Open ended answer
5-3	Do you think that the app satisfies your expectation? Why or why not?	Open ended answer

Findings

This section analyzes the survey results from four perspectives. Prior to the analyses, the author aggregated the responses to the questionnaire. She aggregated responses to questions with multiple options as quantitative data and formed seven graphs to display the results (Figures 2–8). Open-ended answers and miscellaneous answers from multiple options were translated from Lithuanian to English and analyzed accordingly.

A short interview was conducted to verify the process of developing the DNM. The interview was conducted on August 7, 2018, from 4.00 pm to 5.00 pm. The results of this interview are the workflow of the DNM development. The author prepared a table to summarize the results (Table 4).

In the following sections, the author analyzes the survey results from four aspects: basic usage and impressions (Analysis 1), values of DNM (Analysis 2), the role of museum professionals in development (Analysis 3), and advantages and disadvantages (Analysis 4). All figures and a table will appear in the section that analyzes the involvement of museum professionals in app development.

Analysis 1: Basic usage and impressions

This section focuses on museum professionals' basic usage and perceptions of DNM. In the questionnaire, respondents answered questions related to their usage of and impressions of DNM (Question number 1-1, 1-2, 1-3, 1-4, 1-5, 4-1 and 4-2). Thus, analyzing how they perceive the system might provide good clues for understanding the overall usage of DNM in museums.

Most museum professionals use the app as a supplemental tool rather than a primary tool. Figure 2 shows the responses to question 1-1 "How do you usually use DNM when you guide visitors?" The responses imply that some respondents did not use the app, but still told visitors that they had it.

Another aspect of app usage is how museum professionals convey DNM information to visitors. Figure 3 displays responses to Question 1-2, which is about how museum professionals tell information about DNM. According to the results, all professionals who used or introduced the app had direct interaction with visitors. Moreover, both analog means (handouts) and digital means (via the internet) were adopted. In terms of digital communication, its frequency varied; four of them shared information about the app several times a month and another respondent several times since the start of the app. Moreover, Figure 5 shows that some respondents rarely noticed visitors who were already aware of DNM before their visits. It seems that online communication was not successful for the dissemination of DNM.

When visitors entered their museums, professionals directly explained the app. Figure 4 shows details: the majority is "telling how to use it," and "telling in detail about the app." Furthermore, miscellaneous responses are: "all the processes how to use practically" and "Explain by words." These free-description answers could be classified as "telling how to use it'." Thus, most respondents made an effort to publicize the app itself, but did not actively explain how to use it.

The survey also revealed the respondents' perceptions in the context of continuity. Figures 6 and 7 show the answers to questions concerning further use of the app. In short, DNM might be the best tool, but they tend to seek something more advanced in the future. Furthermore, the answers to Question 4-2 provide a wider perspective of technology and museums. Respondents wrote "We continually renew [our] education programs. In the future, there will be [something for] the visitor's needs," and, "I will not be at work. According to the app developer, the duration of the app is between two and three years, and it is possible that the app will be completely unusable owing to the advancement of the devices." This shows that professionals work on museum principles that

do not always correspond to the calendar of technological innovation.

The questionnaire revealed that the app was a supplemental tool for museum professionals and was provided directly to visitors. However, visitors are not actively invited to use the app. In other words, the app does not function as a tool to improve the efficiency of work or advertising. Moreover, the app could be useful for professionals who wish to use it continuously. Nonetheless, the difference in the time spent in museums and technological innovation may obstruct the renewal of apps in the future.

Fig. 3 Result of Question1-2 “How do you introduce the app to visitors?”

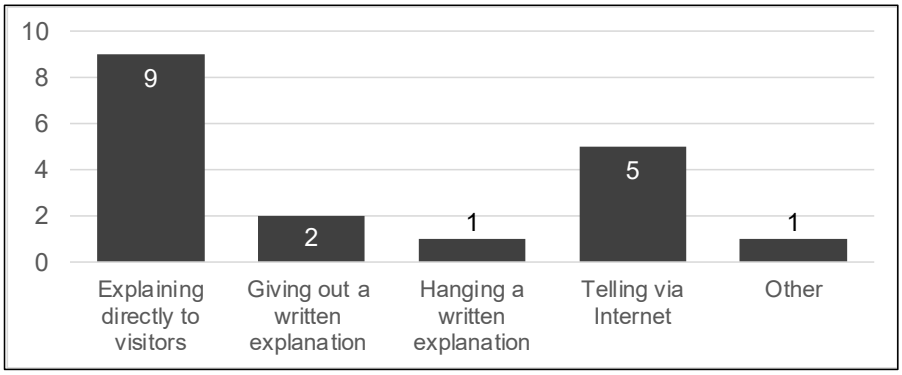


Fig.4 Result of Question1-3 “What do you explain when you show the app to visitors?”

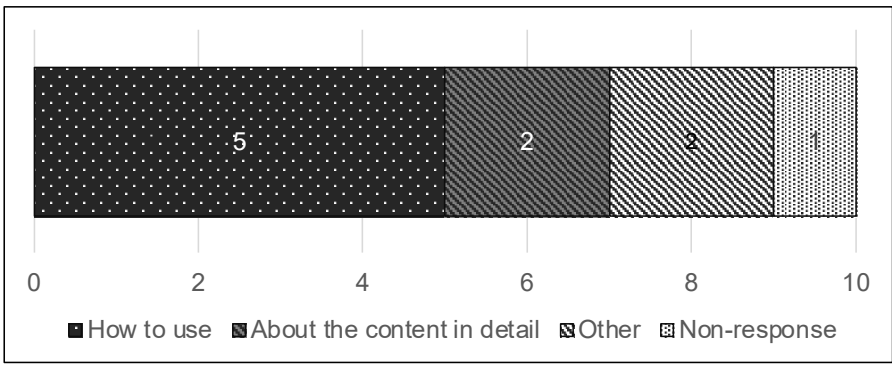


Fig. 5 Result of Question1-4 “How often do you see visitors who know about the app in advance?”

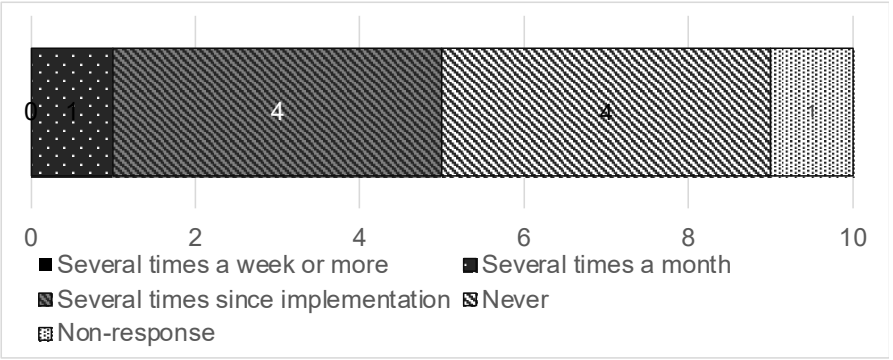


Fig. 6 Result of Question 4-1 "Do you intend to use the app furthermore?"

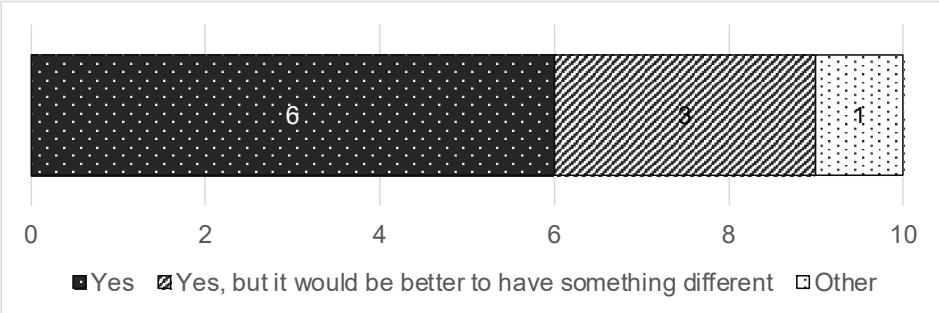
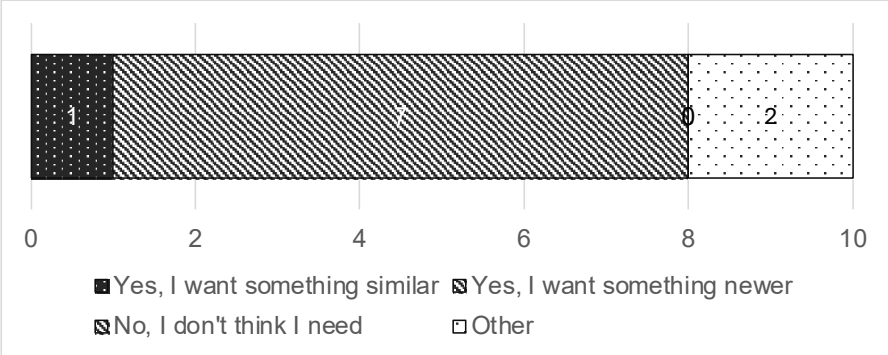


Fig. 7 Result of Question 4-2 "When the app becomes unavailable due to technological reasons, are you going to create new app?"



Analysis 2: Values of DNM

This section considers the values of the app DNM, referring to the AR app value listed by Diek and Jung (2017) from a focus group study. In the discussion of Diek and Jung (2017), they took into account all internal and external stakeholders, except for museum workers who introduced the app to visitors. Diek and Jung (2017) list six values using a stakeholder approach.

(1) Economic value: financially viable for a museum
(2) Experiential value: interactive and enjoyable for visitors
(3) Social value: leading to personal fulfillment and makinbf an impression
(4) Historical and cultural value: letting visitors recognize the historical and cultural value of a museum
(5) Educational value: enhancing visitor learning and educational experience
(6) Epistemic value: provoking strong interest in the potential of AR

The question on the value of the app, Question 3-4, includes the values from (1) to (5) above and "other." Each value was not explained in the questionnaire; however, the respondents were asked to explain the selected values. This study excluded (6) epistemic value from the questionnaire. This value was set to examine the potential of an AR app, since Diek and Jung's (2017) case was a museum before starting to use an AR app. However, this paper focuses on museums that have already started using AR apps, so epistemic value is not applicable. Figure 8 summarizes the responses to Question 3-4. The following paragraphs analyze each value from the free-description answers.

Economic value: None of the respondents selected

an economic value. One commented that "The museum is free of charge, there is no such [value]." All four museums using the app were free of charge and their income was mostly dependent on the budget of the Vilnius municipality. Therefore, the economic value of the apps was irrelevant to the respondents.

Experiential value: In terms of experiential value, museum professionals stated that the app changed visitor perspectives. The app "let [visitors] see the exhibition from another angle," so that "When visitors use the app, they look around the museum differently." Moreover, DNM "let [visitors] have an emotionally engaging experience." Also, as an advantage of technology, "for older people, 3D is still impressive."

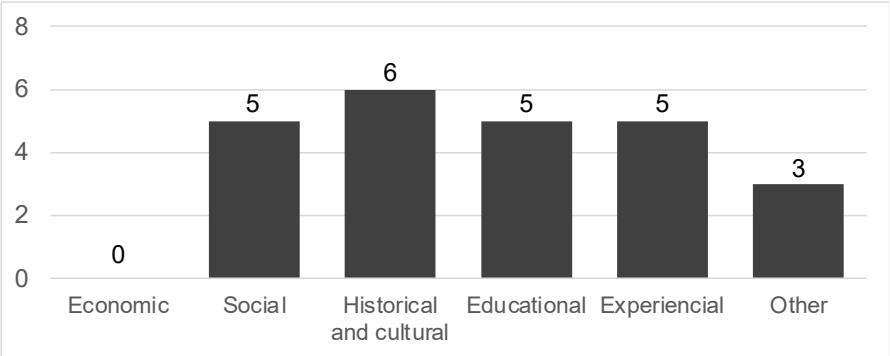
Social value: The majority of respondents thought that the AR app was socially valuable but from different perspectives. One is encouragement of communication, that "the program [the app] stimulate to communicate," and that it "communicate and share outreach education." In this context, communication refers to interactions between museums and visitors. Moreover, the app appears to "help to attract younger visitors [and] family," and to be an option for people "who have a disability." These responses suggest that DNM expanded the range of visitors. Further, the app adds the option for visitors, that they "can individually think about the exhibition, that is interesting for him/her." In short, the DNM expands the possibility of museums attracting visitors.

Historical and cultural value: For respondents, this value indicates the possibility of showing more hidden materials and information. For instance, DNM shows "many facts, which guides do not disclose," and "surrounding information of a museum." More importantly, it uses "many authentic and historical sound and visual records." They emphasized the historical and cultural value of the app itself for highlighting the historical and cultural value of a museum.

Educational value: The educational value for visitors is that they gain new knowledge. Since the nature of DNM is "informative, understandable for various generations," it enables visitors to "know about a [cultural figure] in a short time." It is applicable for younger visitors, that "students can especially have a wider knowledge of the creation of a [cultural figure] and the period that a [cultural figure] lived," and even "teachers offer ideas for a new educational program." This value is an extension of learning through DNM.

Miscellaneous: Some respondents wrote in the "Others", but most were categorized into the six indicated values. Only

Fig. 8 Value of the app: Result of Question 3-4



one response was literally miscellaneous, that said, "modern museum is clearly formed." This implies abstract value, that the app made the museum "modern" in general.

Summary: The overall answers showed that the app values were for museum visitors. Four (or five?) values–experiential, social, historical, cultural, and educational–were related to visitor merit. However, economic value was not recognized because museums are free of charge. They implied that, in terms of DNM value, the goal for the respondents was to increase the number of visitors as well as potential visitors.

Analysis 3: The role of museum professionals at development

How is it possible to develop a smartphone application for museums with a small number of professionals? This section will reveal the answer through the results of both the questionnaire and short interviews. First, to gain developer-side perspective, the overall workflow was discussed, based on the interview, which is briefly summarized in the Table 4. Museum professionals' responses then consider the museum-side perspective.

From the developer's perspective, the overall process of developing DNM took approximately one year from the first plan to publishing for visitors. App development began with museum professionals' understanding of the nature of the app: What can be done and what cannot be done? The preparation was then initiated. At this stage, both developers and museum professionals considered the app content because it mainly relied on the knowledge of professionals expressed at this stage. AR markers were also considered in this phase, which involve identifying objects as potential markers. After preparation, the developers worked on content creation and programming. Similar to other types of app development, testing app usage was required before completion.

Responses to the questionnaire revealed the perspectives of museum professionals. Four respondents responded to the questions regarding their roles during the development phase. The central role the professionals played was "content creation," which included "educational" program content. They have already considered how to utilize it during the development phase. To prepare content for the app, professionals referred to "contents of museum archives" and "the facts of [cultural figure's] life and creation." Even one respondent answered that "I thought of ten themes from [cultural figure's] life and creation" to prepare the contents. Therefore, the AR app not only shows what is hidden in the collection storage room, but also provides supplemental

Table 4. Workflow for developing the DNM.

	Museum professionals	Developer of app
1. Introduction	Museum professionals understand the possibilities and limits of app	Developer explains to museum professionals possibilities and limits of app
2. Preparation	- Museum professionals propose possible contents for the app which is in the museum - Look for objects which could be AR markers with the developer	- Look for objects which could be AR markers with museum professionals
3. Creation	Waiting for completion	Developer prepares contents, and creates app
App completion		
4. Operation	Museum professionals use app in each museum	Developer update and app repair

materials for visitors to better understand the museum.

Although professionals participated in app development, there were some challenges in the finished DNM product. One wrote there were "constant failures and freezing," and another wrote "almost" satisfying, but added that "we wanted more 'hidden points' [AR markers]." Another answered, "We have to try more to communicate with teachers and offer educational [programs] which uses DNM (Daugiau nei matai)." For these professionals, the app fulfilled their requirements; however, further possible advancements are mentioned.

Although the developers thoroughly performed the technologically specialized part of the app development, the details of the app seemed to depend on the museum professionals. They created not only content in the system, but also their usage in the exhibition room. As a finished product, the critical part of DNM follows the expectations of professionals, although there is still a need for improvement.

Analysis 4: Advantages and Disadvantages

All systems have both positive and negative features behind their positive features, and DNM is no exception. To understand how museum professionals accepted DNM, they grasped both the better and weaker points of the app that they noticed. On one hand, the advantages revealed from Question 3-1 are that DNM is impressive and, to date, enables self-guided tours and provides more knowledge. On the other hand, the disadvantages of Question 3-2 and 3-2(?), show problems with the app itself, lack of tablets, lightning in the exhibition room, and anxiety. Further paragraphs will discuss them in more detail with quotes from free-description responses.

Advantages: The first advantage is that DNM is interesting to visitors. One wrote that it is "interesting wither for young and adult [visitors]," showing a wide range of acceptance. Other respondents reported "attraction to younger visitors," and "Elementary school pupils, even up to ninth grade, like it very much." Moreover, DNM "attracts visitors, especially teachers with students," and the function of extending education in the museum could be apparent to professionals. This is interesting, especially in the context of educational use.

As a "new technology," the smartphone app is also an advantage. One stated that "the largest advantage is the AR experience," reflected in another respondent's words "A new usage of media." DNM as an AR in museums is new for visitors. In addition, current technology enables self-guided tours in exhibition rooms for visitors. A professional explained that the app is "comfortable for visitors to use because they do not have to listen to a guide, and they can learn by themselves'."

The responses also mentioned the advantage of the app's main feature: it extends the exhibition room and provides more information. Thus, it is "convenient to know more about [cultural figure's] creation." More directly, the app "visually adds information, let museum to have more possibilities" that museum "combine the old (memorials) and the new (the app)." In short, this application expands what is currently available in museums as a merit for museum professionals.

The advantages show that DNM is interesting and can attract visitors to their exhibitions. The respondents appeared to be interested in two types of advantages: outreach and deepening one's knowledge. Overall, the advantages of the app for museum professionals in this study may be rephrased as advantages for visitors and potential visitors.

Disadvantages: The most dominant disadvantage of DNM is its technological shortcomings. Significant problems in museums are partial or fundamental. The former issue is that the app "doesn't trace mark points [AR markers]," or "doesn't catch signal." Another issue with this application is that the operation ceased. Some mentioned this problem as "Sometimes the tablet freezes," and others mentioned as

"Sometimes the program [app] freezes."

Another problem arises from the lack of hardware, tablet computers, that "tablets are lacking, because we have only one." DNM is downloadable for an individual's smartphone, but since it is often used in educational programs for groups of students, sometimes visitors do not have a smartphone compatible with DNM. Even some visitors "do not want to install the app because it takes up a lot of memory." Thus, "Visitors who have their own telephone [smart phone] is necessary" for them to offer "Daugiau nei matai."

Another disadvantage of AR is its compatibility with museums. First, museums have a low level of illumination in the exhibition rooms, that they feel "Lighting is lacking," and it "influences the work of the app." The museums were initially ordinary flats or houses, so one person thought that DNM "doesn't fit memorial surroundings," since the museums are an authentic space which is preserving the place where cultural figures lived. Another thought "uncomfortable to find a place and points where reacts [AR markers]." These facts suggest that museums may not be the best venue for using the AR app.

The disadvantages showed that DNM has technological issues that prevent visitors from using it and also does not fully fit memorial museums. These disadvantages were not mentioned in previous studies, perhaps because the data were biased; pro-app professionals were involved in the studies. However, they are challenges to overcome, but not a fatal feature, to stop using DNM.

Summary: This section discusses the advantages and disadvantages of the DNM app as recognized by museum professionals. Both advantages and disadvantages consider benefits to visitors. In other words, the respondents were pursuing a better experience of visitors in their venue, and DNM was helpful in achieving that goal, but there were also some shortcomings.

Discussion and conclusion

This paper presents a case study of an AR app DNM implemented in Vilnius City museums in the Republic of Lithuania. In 2018, the author conducted a questionnaire survey and a short interview. The previous section analyzed the survey results from four aspects. They are basic usage and impressions, values of DNM, role of museum professionals in development, and advantages/disadvantages. The following discussion aims to answer the primary question of this study: How do museum professionals accept augmented reality guidance for visitors?

Museum professionals in the four museums either accepted the AR app as a supplemental tool or actively recommended it to visitors. Some museum professionals were involved in the app development and content preparation. The advantages they remark are mainly something worthy of visitors and a potential vision of outreach for general and deepening experiences. Similarly, the disadvantages include obstacles for visitors, mainly technological shortcomings, to use the app comfortably. The general attitude of museum professionals toward the app can be described as forward-looking.

The respondents perceived four (five?) values of DNM: experiential, social, historical, cultural, and educational. Social values match the advantages of outreach. In addition, experiential, historical, cultural, and educational values match the advantages of deepening experiences. The value of the AR app by Diek and Jung (2017) mirrors its advantages.

Therefore, the app serves primarily as a merit for museum visitors. In other words, the merits of museum professionals have not been identified. Whether museum professionals, especially those who directly interact with visitors, understand, use, and recommend directly affects visitors' access to new possibilities; museum merits are perhaps crucial for users. However, the respondents did not express inconvenience; therefore, visitor-oriented app

development was not a problem in this case.

A limitation of this study is that visitors' perspectives were lacking, as it focused on museum professionals. Museum professionals observed the visitors' advantages and values discussed in this article. Therefore, further studies on visitors are required to verify whether professional assumptions and visitors' feelings correspond. However, this study aimed to examine how museum professionals perceive the AR app; therefore, this limitation does not influence the nature of this study.

Consequently, museum professionals positively utilize the AR app when they are convinced of its value for visitors. Although some issues remain that prevent museum professionals and visitors from using the app, it is collectively conceived as useful for visitors. Despite its positive and negative technical features, they may accept any AR app similar to DNM and utilize it when they admit that it is useful for visitors.

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Conflict of Interest Declaration

The author declares that she has no affiliations with or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

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摘　要

2010 年代後半、拡張現実（AR）スマートフォンアプリの導入が、博物館において世界的な流行した。AR アプリ導入の試みに関する先行研究は、主に来館者の利便性を関するものであったが、博物館の専門職員が AR アプリをどのように受け入れているのか、という観点が欠けていた。本研究では、リトアニア・ヴィリニュス市のヴィリニュス記念博物館管理局所管の 4 館の博物館における AR アプリ「Daugiau nei matai（ドウギョウ・ネイ・マタイ、見るよりももっと多く、という意）」の事例において、この問いに基づき調査を行なった。調査としては、アプリの導入に関わった 10 名の博物館専門職員全員を対象とした悉皆アンケート調査と、アプリ開発者へのインタビュー調査を実施した。調査結果は、基本的な利用方法と印象、DNM の価値観、開発における博物館専門職員の役割、利点・欠点の 4 つの側面から分析された。その結果、対象事例において博物館専門職員は、AR アプリが来館者にとって価値があると判断し、活用していることがわかった。

キーワード：博物館， 拡張現実， リトアニア， 博物館教育

令和５年度
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（キンタナ　オベラー　マリア　ガブリエラ，動物医科学）

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32. Development of initial composting diagnostic technology to support the operation and management of composting facilities
(Riku Nishimura,Engineering for Agriculture)

33. Investigating factors influuncing fat color and fatty acid composition, and estimating genetic parameters in Japanese Black delivered cows
(Nagisa Nomura,Animal Production Science)

34. Investigation of corticosteroid levels in the coats of Holstein calves
(Hiroki Fushuku,Animal Production Science)

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36. いもち病菌*Pyricularia oryzae* に属する2系統の*Avena* 分離菌の*Avena* 属植物に対する病原性パターンの比較
（保科　萌，植物生産科学）

36. Comparison of pathogenicity patterns of three *Avena* isolates of the blast fungus *Pyricularia oryzae* against *Avena* species.
(Moe Hoshina,Plant Production Science)

37. ドライ熟成肉由来の真菌株が産生する酵素に関する研究
（細野　未紗，食品科学）

37. The study on the enzymes produced by fungal strains derived from Dry-aged beef
(Misa Hosono,Food Science)

38. YOLOv8による動物トリパノソーマ症の原因寄生虫の自動検出
（本多　泰河，動物医科学）

38. Automatic detection of parasites causing animal trypanosomosis using YOLOv8
(Taiga Honda,Veterinary Life Science)

39. 北海道の天然生広葉樹林に生息するエゾモモンガ *Pteromys volans orii* の採食資源に関する基礎生態学的研究
（本馬　維子，環境生態学）

39. Basic ecological studies on the feeding resources of the Siberian flying squirrel *Pteeromys volans orii* ib natural broad-leaved forests in Hokkaido, Japan
(Yukiko Homma,Ecology and Environmental Science)

40. アカギツネのエキノコックス感染予防に関する基礎研究−駆虫薬入りキツネ用ベイトの散布効果の検証−
（松本　大亮，環境生態学）

40. Basic research on prevention of echinococcus in red foxes -Examination on the effectiveness of spreading fox bait with anthelmintic praziquantel-
(Daisuke Matsumoto,Ecology and Environmental Science)

41. 清酒酒質の多様化と向上に資する酵母の取得
（松本　麻由子，食品科学）

41. Acquisition of yeasts that contribute to diversification and improvement of *sake* quality
(Mayuko Matsumoto,Food Science)

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（真中　千明，植物生産科学）

42. Evaluation of genetic diversity and QTL analysis of traits for seminal root elongation in wheat
(Chiaki Manaka,Plant Production Science)

43. 道管に存在する凍結の伝播を防ぐバリア構造が芽吹き前後のブドウ冬芽の耐寒性を決定する
（廻渕　凌匠，植物生産科学）

43. Ice barrier srructure in vessels determines the freezing resistance of winter buds of grapevines in earle spring
(Ryots Mawaribuchi,Plant Production Science)

44. ロボットトラクタと連携するスプレーヤのブーム自動開閉システムの開発に関する研究
（水野　雄介，農業環境工学）

44. The study on the development of an automatic boom opening and closing system for boom sprayer linked to a robotic tractor
(Yusuke Mizuno,Engineering for Agriculture)

45. ホルモン処置効率化のための卵巣所見に基づくウシの発情周期推定に関する研究
（宮崎　智代，動物医科学）

45. Study on estimation of bovine estrous cycle based on ovarian findings to improve efficiency of hormonal treatment
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46. 福島牛（黒毛和種肥育牛）における超音波画像からの生体時BMS推定への人工知能の適用
（宮田　あゆ，家畜生産科学）

46. Application of artificial intelligence to predicting BMS from ultrasound images of live Fukushima beef (Japanese Black cattle)
(Ayu Miyata,Animal Production Science)

47．防風林の多面的機能の把握
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（渡邊　裕介，環境生態学）

50．トウモロコシの内生昆虫寄生菌によるアワノメイガ（*Ostrinia furnacalis* ）の微生物防除
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51．北海道の大規模肉用牛肥育経営における死廃・疾病リスクマネジメントに関する考察
（ジン サンキョン，農業経済学）

52．*In vitro* 培養試験における特定のフェニルプロパノイドが微生物叢に及ぼす影響
（スー テッ ムエ ナイン，家畜生産科学）

53．土地返還プログラムが土地請求者の生活に与える影響：リンポポ州モパニ地区におけるプロジェクトの事例研究
（マスク　ミリセント エリタ，農業経済学）

54．海藻摂取が新生子牛の発育と健康状態に及ぼす影響
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55．白色担子菌におる木材資源の栄養価向上
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56．マラウイにおける家畜のマダニ媒介病原体の分子疫学調査
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（臼井　野々花，家畜生産科学）

47．Assessing the multiple functions of windbreaks
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48．Composting characteristics of livestock manure mixed with biochar and the effect of applying biochar-mixed compost
(Kotoha Watanabe,Engineering for Agriculture)

49．Environmental characteristics of streams usef by raccoons in Tokachi district, Hokkaido
(Yusuke Watanabe Macharia,Ecology and Environmental Science)

50．Microbial control of Asian corn borer(Ostrinia furnacalis) by endophytic entomopathogenic fungi on maize
(Sambo Elcidio Eugénio,Agricultural Economics)

51．A Study on the Mortality and Disease Risk Management of Large-Scale Beef Fertility Management in Hokkaido
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52．Consequences of selected phenylpropanoids on rumen microbial potentials during *in vitro* fermentation
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54．Effect of seaweed supplementation on growth and health condition of neeborn calf
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55．Improvement of nutritive values of wood resources by white rot fungi
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56．Molecular epidemiological investigation of tick-borne pathogens of domestic animals in Malawi
(Chikufenji Boniface Onesmo,Veterinary Life Science)

57．Comparison of the immune response by TLR2 activation and sperm in bovine oviduct epithelial cells
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２．北海道の普通畑土壌におけるコムギのケイ素吸収が生育や品質に及ぼす影響
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３．ウシの精子−子宮免疫クロストークを調節するTLR2の分子動力学のコンピューターモデリングに関する研究
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４．薬用植物成分のヒトノロウイルス代替ウイルス、新型コロナウイルスおよびA型インフルエンザウイルスに対する殺ウイルス効果に関する研究
（サブリン ミルザ シンシア）

５．多機能超音波画像診断によるセラピーホースに適した馬の妊娠および胎子検査
（高　遠之）

６．ゼブラフィッシュを用いた環境汚染物質の内分泌撹乱作用と発生毒性に関する研究
（チャン シン）

７．バレイショにおける青枯病抵抗性に関する研究
（波部　一平）

８．馬の選択的卵管通水法に関する研究
（井上　裕士）

９．コモンマーモセットの進行性糸球体腎症に関する病理学的研究
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10．ブタ脂肪細胞の褐色化に関する外因性刺激および分子機構の解明
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11．ウマ消化管内発酵の安定化に向けた細菌叢動態に基づく多面的解析
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２．Effects of silicon nutrition on wheat growth and quality in upland soils of Hokkaido
(SOURIDETH Vilayphone)

３．Computational modelling for molecular dynamics of TLR2 that regulates spermuterine immune crosstalk in cattle
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４．Studies on the virucidal activity of medicinal plant components against a human norovirus surrogate, severe acute respiratory syndrome coronavirus 2, and influenza A virus
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５．Multifunctional ultrasound examination of pregnancy mare and fetal in pony for Equine- Assisted Therapy
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６．Research on the endocrine disrupting potential of environmental contaminants and their developmental toxicity using zebrafish
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７．Studies on resistance to bacterial wilt caused by the Ralstonia solanacearum species complex in potato
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８．Selective hysteroscopic hydrotubation in mares
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９．Pathological studies on progressive glomerulonephropathy in common marmosets
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11．Multifaceted study based on microbial dynamics for stable fermentation in equine hindgut
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13. ジンバブエにおける牛タイレリア症の予防・抑制・撲滅に向けた農家の知識と行動：プリンシパル・エージェント問題と家畜衛生管理
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14. 腸内メタン軽減の調査：さまざまな影響の評価　反芻動物の発酵、摂取、消化率に関する資料
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16. 発達期ゼブラフィッシュを用いた形態観察およびトランスクリプトーム手法による新興環境汚染物質の毒性評価と毒性機序解明に関する研究
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17. バベシア共感染における種間免疫と疾患調節の研究
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12. Analyzing quantitative trait loci of agronomic traits for plant architecture and yield in adzuki bean (*Vigna angularis*)
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13. Farmer knowledge and behavior towards prevention, control and eradication of bovine theileriosis in Zimbabwe: Principal-agent problem and animal health management
(NHOKWARA Shelton Munyaradzi)

14. Investigating Enteric Methane Mitigation: Assessing the Impact of Various Materials on Ruminants' Fermentation, Intake, and Digestibility
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15. Molecular epidemiology and genotypic diversity of equine piroplasma parasites
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16. Studies on toxicity assessment of emerging environmental pollutants and unraveling the underlying mechanisms of toxicity based on the morphological and transcriptomic approaches using developing zebrafish
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17. Investigating cross-species immunity and disease modulation in *Babesia* co-infections
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