

Understanding Barriers to Educational Mobility: Examining the Medical Profession in Denmark

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Motivation. Access to prestigious educational institutions is characterized by limited social diversity and exhibits a high degree of occupational reproduction (Chetty et al., 2020; Polyakova et al., 2020). Even in Denmark, a country with relatively high intergenerational mobility, the chance of graduating from some of the most prestigious educational programs is subject to significant socio-economic inequalities (Thomsen, 2022).

Occupational reproduction and high entry barriers to an occupation can offer certain advantages for society, such as fostering specialized knowledge within specific fields (Laband and Lentz, 1983).¹ However, barriers to enter into a profession can lead to inefficient allocation of talent. For instance, if skilled individuals are restricted in their occupational choice because of their gender, social or geographic origin. Barriers can lead to a lack of diversity within an occupation. Too much homogeneity among professionals is increasingly recognized as having negative consequences for innovation and development of novel ideas (Page, 2019; Nielsen et al., 2017). In addition, supply side homogeneity (e.g., among doctors, teachers, judges) can have negative consequences for population segments underrepresented on the demand side (patients, students, accused) (Dee, 2005; Carrell et al., 2010; Boyd, 2016; Greenwood et al., 2018; Alsan, Garrick, and, Graziani, 2019; Kristiansen and Sheng, 2022).

Research Question. We will examine the influences of university access, labor demand, and labor market regulations on intergenerational mobility in education and occupational reproduction. Our proposed research agenda consists of two parts. Specifically, we ask:

- **How do access to education and labor market regulations affect intergenerational mobility?**
- **Does the return to skills vary by social background and gender?**

This study will be conducted within the context of Denmark, with a focus on one of the most esteemed professions: medical doctors.

¹ From an individual perspective, occupational reproduction can also enhance career progression through social networks and favoritism.

Medical doctors do not only hold esteemed positions but also belong to some of the highest paid professions. Doctors serve as crucial components in promoting public health, and public health holds significant societal importance. For instance, healthcare expenditure amounts to 9.7% of GDP in OECD countries. The labor market for doctors is subject to stringent regulations, and there are barriers to access medical training. Furthermore, the phenomenon of occupational reproduction is particularly pronounced among medical doctors, whereby individuals with parents in the medical profession are more likely to pursue a career as doctor themselves. This occupational reproduction appears to be more prevalent among doctors in comparison to other prestigious occupations, such as lawyers (Polyakova et al., 2020).

Methodology. We approach the research question from an applied microeconomic angle. Empirical analyses of concepts and mechanisms we seek to investigate are very data demanding, and sources that contain the relevant micro-data on complete populations of professionals are extremely rare. We meet this challenge by investigating the historical environments in Denmark. We digitize old hardcover books and leverage recent developments in computer science to extract information suitable for quantitative analysis. Using new computer science tools, we have successfully trained an artificial neural network to extract data from the books. Our unique and comprehensive micro database consists of approximately 90,000 biographies of all medical doctors that worked in Denmark from 1479-2000. These unique data include family ties, parents' occupation, and workplace spells. Appendix A shows an example of a biography, and how we used machine learning methods to extract information from the biographies.

Together with administrative data from contemporary times (1980-2020), the biographies will serve as a foundation for the database. With the proposed project, we will be able to add data from yearbooks from the University of Copenhagen (dating back to 1793). From the yearbooks, we will obtain detailed information on the doctors' skills measured by exam grades, both from university and high school, in a wide variation of courses (see Appendix B for an example). Compared to the administrative data, our database has the advantage of allowing us to link parental occupation for older cohorts.² In addition, the data on grades is more comprehensive than what we can obtain from administrative data. This will allow us to study the distribution of skills by gender, socioeconomic and geographic backgrounds, as well as explore the role of meritocracy in intergenerational mobility.

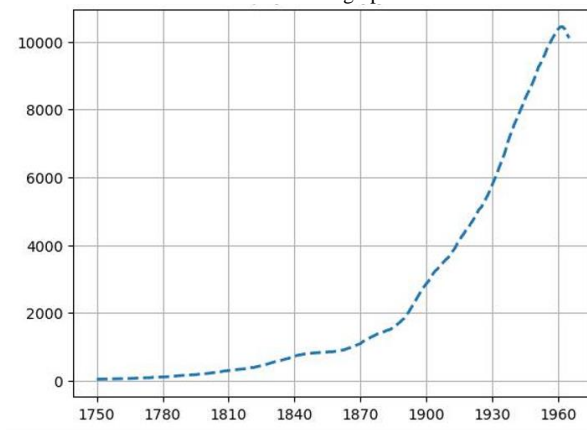
The access to the labor market for doctors and to medical training have changed tremendously over time, and the number of doctors working in Denmark has changed drastically, see Figure 1 panel A and

² In the administrative data, we can link parental information for individuals born after 1956, but only for those individuals who have parents living in Denmark.

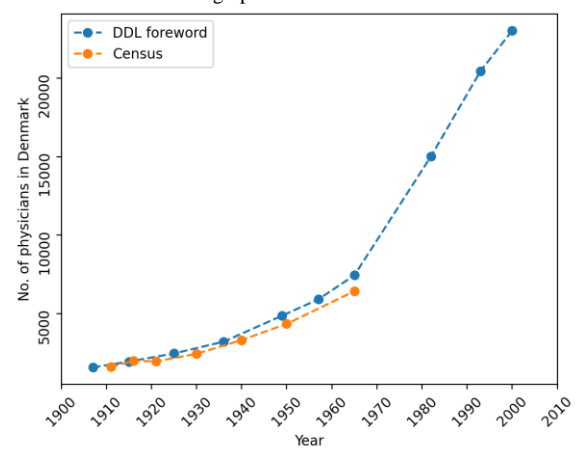
B.³ However, the degree of occupational reproduction has been relatively stable ranging from around 10-20 percent, see Figure 1 panel C and D. We hypothesize that expansions in the access to medical training allowed a more diverse group to enter the profession and that restrictions to the access could have the opposite effect.⁴ These patterns are however not given. Ram (1990) and Borgonovi and Marconi (2020) suggest that more accessible higher education may not necessarily decrease educational inequality.

Figure 1: Number of medical doctors in Denmark and degree of occupational reproduction

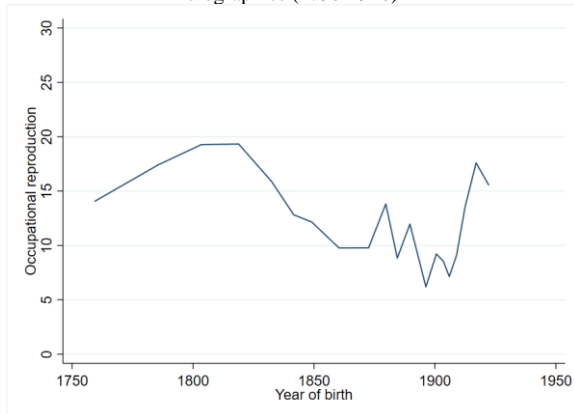
Panel A: Number of medical doctors in Denmark from 1750-1960 from the doctors biographies



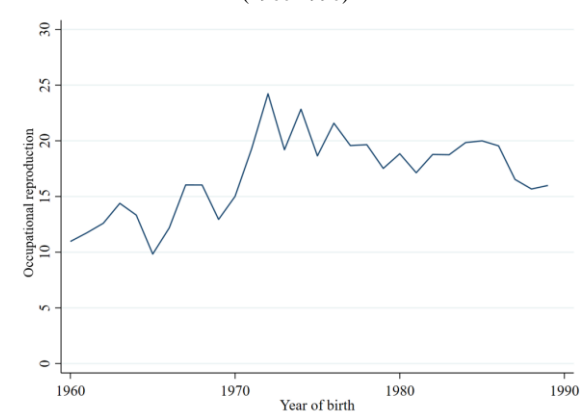
Panel B: Number of medical doctors in Denmark from 1900-2000 from the doctors biographies and validated with census data



Panel C: Percent of doctors with a doctor parent from the doctor biographies (1750-1920)



Panel D: Percent of doctors with a doctor parent from the registers (1960-1990)



Policy Relevance. Understanding how different institutional settings, barriers, and family background impact access to higher education and prestigious positions in the society is a policy relevant question. First, a high persistence in social status and prestigious positions in society as a cause of family background rather than effort and merit may result in inefficient use of human resources and result in

³ We see particularly large expansions in the mid-19th century, in the early 20th century and in the 1960-1970. All these periods represent times of liberating access to the profession.

⁴ Expansions in the access to medical training could for examples be openings of new medical schools: Aarhus University in 1935 and University of Southern Denmark in 1966. Restrictions to access to medical training could for example be the introduction of GPA cut-offs to access the University of Copenhagen in 1977, and the decrease in number of enrolled medical students during in response to high doctor unemployment in the 1980s.

lost talents. Secondly, these patterns may impact social cohesion and cooperation among citizens as it can be deemed unfair (Mogstad and Torsvik, 2022). Even in an universal educational system there can be barriers for less privileged people to enter certain positions in society, which can have large consequences, e.g., for innovation and supply of services provided for less represented parts of the population.

Contribution to the Academic Literature. Our research project will advance the literature along several margins. First, we aim to contribute to the economics literature by studying which institutional factors can affect intergenerational mobility in education. Universal provision of public services, e.g. education, does not necessarily mitigate inequalities, as more advantaged families are better able to access, utilize and influence universal programs (Ceci and Papierno, 2005).⁵ The expansion of higher education in Denmark has been shown to increase mobility, however driven by already privileged parts of the population (Karlson and Landersø, 2021). The choice to enrol and the type of higher education may be impacted by role models (Porter and Serra, 2020; Wagner et al., 2020) and high school peers (Cattan, Salvanes and Tominey, 2022).

Secondly, we want to study if academic achievements impact later labor market outcomes differently depending on people's social background, gender, or ethnicity. Some studies show that even with the same level of education, the return may differ by social background, gender, or other characteristics. For example, Seth Zimmerman (2019) shows that the high return to elite education is entirely concentrated among male applicants from high income backgrounds. Bertrand, Goldin, and Katz (2010) show that male graduates from top MBA programs in the US experience greater labor market success than their female peers.

Team and Co-financing: The research will be conducted by PI Ida Lykke Kristiansen and in equal collaboration with Torben Heien Nielsen (Associate professor, Economics, Uni of Cph), Frederik Plesner Lyngse (Assistant professor, Public Health, Uni of Cph) and Kathrine Lorentzen Aaby (PhD-student, Economics, Uni of Cph). The three latter researchers bring their own funding from a Sapere Aude grant (Independent Research Fund Denmark) rewarded in 2019. We got legal permission from the publishers to gather, digitize and conduct research on the books that contain the biographies spanning. Our data management is compliant with General Data Protection Regulation (GDPR), Danish legislation, and Danish Code of Conduct for Research Integrity.

⁵ This is also known as the the "Mathew effect" from the Gospel according to Matthew: "For unto every one that hath shall be given, but from him that hath not shall be taken away even that which he hath" (Ceci and Papierno, 2005).

Timeline and Expected Output. The output of the project is expected to be contained in one academic paper. We aim for a publication in a top general interest journals (e.g., Science), or a top journal in economics (e.g., AER). In table 1, we give a broader overview of the timeline for the proposed project.

Table 1: Timeline

Date	To do
August 2023-December 2023	Transcribing university exam grades (RA)
January 2024-April 2024	Transcribing high school grades (RA)
May 2024 – July 2024	Transcribing additional information (RA)
December 2024	Submission to academic journal

Literature:

- Alsan, M., Garrick, O., & Graziani, G. (2019). "Does diversity matter for health? Experimental evidence from Oakland." *American Economic Review*, 109(12), 4071-4111.
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- Boyd, C. L. (2016). "Representation on the courts? The effects of trial judges' sex and race." *Political Research Quarterly*, 69(4), 788-799.
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- Dee, T. S. (2005). "A teacher like me: Does race, ethnicity, or gender matter?" *American Economic Review*, 95(2), 158-165.
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- Laband, D. N., & Lentz, B. F. (1983). "Like father, like son: Toward an economic theory of occupational following." *Southern Economic Journal*, 474-493.
- Mogstad, M., & Torsvik, G. (2021). "Family Background, Neighborhoods and Intergenerational Mobility." In S. Lundberg & A. Voena (Eds.), *Handbook of the Economics of family* (1st ed.).
- Nielsen, M. W., Alegria, S., Börjeson, L., Etkowitz, H., Falk-Krzesinski, H. J., Joshi, A., ... & Schiebinger, L. (2017). "Gender diversity leads to better science." *Proceedings of the National Academy of Sciences*, 114(8), 1740-1742.
- Page, S. E. (2019). "The diversity bonus: How great teams pay off in the knowledge economy." Princeton University Press.
- Polyakova, M., Persson, P., Hofmann, K., & Jena, A. B. (2020). "Does medicine run in the family—evidence from three generations of physicians in Sweden: retrospective observational study." *BMJ*, 371.

Porter, C., & Serra, D. (2020). "Gender differences in the choice of major: The importance of female role models." *American Economic Journal: Applied Economics*, 12(3), 226-254.

Ram, R. (1990). "Educational expansion and schooling inequality: International evidence and some implications." *The Review of Economics and Statistics*, 266-274.

Thomsen, J.-P. (2022) "Social ulighed i adgangen til danske universitetsuddannelser", *Samfundsøkonomen*, (3), s. 53-60.

Wagner, K. L., Riise, J., Willage, B., & Willén, A. (2020). "Can Female Doctors Cure the Gender Stemm Gap? Evidence from Randomly Assigned General Practitioners." Forthcoming in *Review of Economics and Statistics*.

Zimmerman, S. D. (2019). "Elite colleges and upward mobility to top jobs and top incomes." *American Economic Review*, 109(1), 1-47.

Appendix A:

We annotated 500 biographies and used them to develop a neural network that could extract data from the remaining biographies. This neural network was developed by fine-tuning an XLM-R model, a "foundation language model" made publically available in 2019, to solve our extraction task. We specifically used a multilingual foundation language model to be able to handle Danish text. To adequately model the data contained in a biography, we developed a custom architecture that does both extraction and sub-extraction simultaneously. This multi-label token classification architecture was especially important because the biographies contain interdependent events; our neural network needed to be able to identify each event and break it down into "what happened", "where" and "when", while having access to the context around each event. This was achieved by our custom architecture.

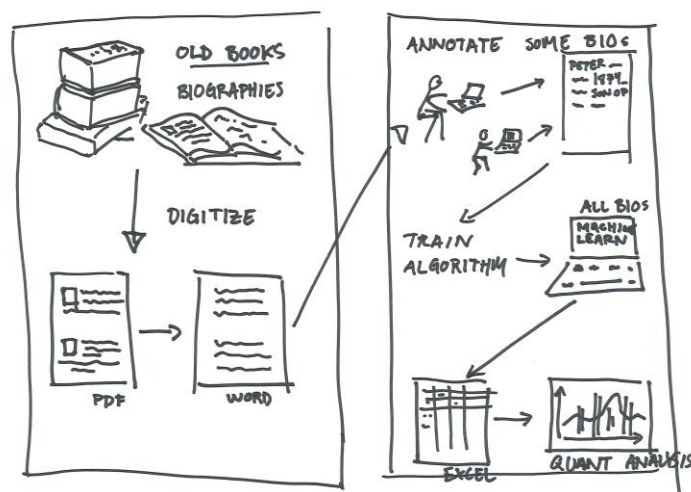


Figure A.1: Example on annotating a biography and the original

Jacobi, Wilhelm August, f. 10. Aug. 1825 i Sorø, S. af Arkitekt Johannes Paulus J. og Ida Margrethe Kirstine Bagge. (Onkel til Læge William A. A. F. J.) Student 47 II Sorø. Underlæge ved Lasaret paa Gottorp 50—51. Koleralæge 53. Med. Eks. V. 56 laud. Konst. Kand. ved Fred. Hosp. 56. Overskibslæge 56—57. Kand. ved et midlertidigt St. Annæ Hosp. for Tyfusptt. 57. Underlæge i Hæren 58. — Prakt. i Sæby Maj 58, samtidig konst. Distriktslæge i Frederikshavn April—Aug. 63. Medl. af Sæby Byraad 76—80. Distriktslæge i Sæby 2. Marts 71, i Næstved 20. Dec. 79. Læge ved Næstved Sygeh. R.* 15. Nov. 88. Afsked som Distriktslæge og D.M. 19. Okt. 05.

Gift i Kbhvn. 18. Juni 61 med Henriette Caroline Josephine Gerner, f. 5. Maj 41 i Kbhvn., d. 30. Okt. 04 i Næstved, D. af Skibsbygger i Sætetaten Henrik G. og Nicoline Gaaser.

bio_doctor_name	1	bio_event	2	bio_sex_indication	3	bio_father_occupation	4
bio_father_name	5	bio_mother_occupation	6	bio_mother_name	7	bio_partner	8
bio_unsplit_doctor	9	bio_other_relation	0	event_born	q	event_dead	w
event_education	e	event_work	t	event_appointed	a	event_other	s
event_time	d	event_loc_geo	f	event_loc_org	g	event_loc_person	z
event_grade	x	partner_married_date	o	partner_married_place	v	partner_partner_occupation	b
partner_partner_name	y	partner_event	i	partner_sex_indication	o		
partner_father_occupation	p	partner_father_name	j	partner_mother_occupation	k		
partner_mother_name	l	partner_other_relation	n				

Jacobi, Wilhelm August, f. 10. Aug. 1825 i Sorø, S. af Arkitekt Johannes Paulus J. og Ida Margrethe Kirstine Bagge. (Onkel til Læge William A. A. F. J.) Student 47 II Sorø. Underlæge ved Lasaret paa Gottorp 50—51. Koleralæge 53. Med. Eks. V. 56 laud. Konst. Kand. ved Fred. Hosp. 56. Overskibslæge 56—57. Kand. ved et midlertidigt St. Annæ Hosp. for Tyfusptt. 57. Underlæge i Hæren 58. — Prakt. i Sæby Maj 58, samtidig konst. Distriktslæge i Frederikshavn April—Aug. 63. Medl. af Sæby Byraad 76—80. Distriktslæge i Sæby 2. Marts 71, i Næstved 20. Dec. 79. Læge ved Næstved Sygeh. R.* 15. Nov. 88. Afsked som Distriktslæge og D. M. 19. Okt. 05. Gift i Kbhvn. 18. Juni 61 med Henriette Caroline Josephine Gerner, f. 5. Maj 41 i Kbhvn., d. 30. Okt. 04 i Næstved, D. af Skibsbygger i Sætetaten Henrik G. og Nicoline Gaaser.

Appendix B:

Kandidaternes Navne.		Forberedelsesexamen.				Special-Examen.		karaktererne.										Hovedkarakter.			
		Koni.	Fysik.	Zoologt.	Botanik.	Tilsvamen.	Examen.		Mundtlig Prøve.					Skriftlig Prøve.					Taj-værdiernes Sam.		
							Iste Del.		Mundtlig Prøve.		Fysiologt.	Farmakologt.	Medicinsk Anatomi.	Medicinsk Kirurgt.	Medicinsk Kirurgt.	Medicinsk Kirurgt.	Medicinsk Kirurgt.	Medicinsk Kirurgt.		Medicinsk Kirurgt.	Medicinsk Kirurgt.
Januar—Februar 1906.																					
Balslev, Lauritz (1899) Fb. Ex. 1901	.....	8	16	13	13	16	15	13	16	9 $\frac{1}{2}$	16	9 $\frac{1}{2}$	11 $\frac{1}{2}$	13	11 $\frac{1}{2}$	11 $\frac{1}{2}$	13	11 $\frac{1}{2}$	11 $\frac{1}{2}$	184 $\frac{1}{2}$	Landabilis.
Christensen, Christen Rasmus (1898) Fb. Ex. 1901	.....	5	5	8	13	8	13	13	13	9 $\frac{1}{2}$	9 $\frac{1}{2}$	9 $\frac{1}{2}$	11 $\frac{1}{2}$	9 $\frac{1}{2}$	11 $\frac{1}{2}$	13	13	13	123 $\frac{1}{2}$	Hand illand. 1.	
Clemmensen, Johannes (1898) Fb. Ex. 1900	.....	13	8	13	8	8	8	8	8	20 $\frac{1}{2}$	20 $\frac{1}{2}$	20 $\frac{1}{2}$	13	13	9 $\frac{1}{2}$	9 $\frac{1}{2}$	9 $\frac{1}{2}$	7	7	157 $\frac{1}{2}$	Hand illand. 1.
Groze-Petersen, Knud Helge Ross (1897) Fb. Ex. 1899	.....	5	13	13	8	13	13	13	13	20 $\frac{1}{2}$	20 $\frac{1}{2}$	20 $\frac{1}{2}$	7	11 $\frac{1}{2}$	14	8	9 $\frac{1}{2}$	9 $\frac{1}{2}$	8	169 $\frac{1}{2}$	Landabilis.
Hansen, Asger (1898) Fb. Ex. 1901	.....	16	16	8	13	13	13	13	13	27 $\frac{1}{2}$	27 $\frac{1}{2}$	5	11 $\frac{1}{2}$	9 $\frac{1}{2}$	13	11 $\frac{1}{2}$	13	11 $\frac{1}{2}$	9 $\frac{1}{2}$	148 $\frac{1}{2}$	Hand illand. 1.
Jensen, Ida Kristine Elise (1896) Fb. Ex. 1900	.....	5	5	5	16	16	16	16	16	13 $\frac{1}{2}$	13 $\frac{1}{2}$	5	5	7	7	7	7	7	7	81	Hand illand. 2.
Møller, Erik Vilh. Harvig (1897) Fb. Ex. 1900	.....	16	8	8	13	13	13	13	13	23 $\frac{1}{2}$	23 $\frac{1}{2}$	13	11 $\frac{1}{2}$	13	11 $\frac{1}{2}$	13	11 $\frac{1}{2}$	11 $\frac{1}{2}$	9 $\frac{1}{2}$	129 $\frac{1}{2}$	Hand illand. 1.
Nielsen, Søren Martinus (1896) Fb. Ex. 1900	.....	16	8	13	8	13	13	13	13	23 $\frac{1}{2}$	23 $\frac{1}{2}$	16	15	11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	7	174	Landabilis.
Nordenfjeld, Jacob (1899) Fb. Ex. 1901	.....	16	13	13	8	16	16	16	16	26 $\frac{1}{2}$	26 $\frac{1}{2}$	13	14	11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	8	161 $\frac{1}{2}$	Landabilis.
Rasch, Arnljot Constantus Victor (1895) Fb. Ex. 1898	.....	5	8	8	5	8	8	8	8	13 $\frac{1}{2}$	13 $\frac{1}{2}$	11	9 $\frac{1}{2}$	5	5	5	5	5	8	90 $\frac{1}{2}$	Hand illand. 2
Sigurdsson, Jon Hjaltalin (1898) Fb. Ex. 1900	.....	16	8	8	13	13	13	13	13	23 $\frac{1}{2}$	23 $\frac{1}{2}$	16	13	14	14	14	14	14	15	192	Landabilis.
Sternbich, Augustinus Herman (1898) Fb. Ex. 1901	.....	8	13	8	16	16	16	16	16	23 $\frac{1}{2}$	23 $\frac{1}{2}$	16	16	11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	8	145 $\frac{1}{2}$	Hand illand. 1.
Sverné, Hans Kristian Lauritz Hansen (1895) Fb. Ex. 1901	.....	16	16	16	16	16	16	16	16	32 $\frac{1}{2}$	32 $\frac{1}{2}$	16	11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	15	195 $\frac{1}{2}$	Hand illand. 1.
Ussing, Johannes (1897) Fb. Ex. 1899	.....	5	5	8	5	13	13	13	13	13 $\frac{1}{2}$	13 $\frac{1}{2}$	8	9 $\frac{1}{2}$	13	11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	14	141	Landabilis.
Juni—Juli 1906.																					
Andersen, Karen Marie (1899) Fb. Ex. 1901	.....	8	16	8	16	8	8	16	16	22 $\frac{1}{2}$	22 $\frac{1}{2}$	15	11 $\frac{1}{2}$	7	7	7	7	7	7	181	Landabilis.
Berg, Poul Emil (1899) Fb. Ex. 1901	.....	8	16	16	8	13	13	13	13	24 $\frac{1}{2}$	24 $\frac{1}{2}$	9 $\frac{1}{2}$	15	13	13	13	13	13	11 $\frac{1}{2}$	180 $\frac{1}{2}$	Landabilis.
Christensen, Hakon Blahøj (1900) Fb. Ex. 1902	.....	16	8	13	13	13	13	13	13	25	25	6	13	13	13	13	13	13	15	158 $\frac{1}{2}$	Landabilis.
Christensen, Lauritz Chr. (1895) Fb. Ex. 1901	.....	13	5	8	8	13	13	13	13	18 $\frac{1}{2}$	18 $\frac{1}{2}$	9 $\frac{1}{2}$	9 $\frac{1}{2}$	5	5	5	5	5	7	141	Hand illand. 1.
Cleos, Oskar Jacob Carl (1898) Fb. Ex. 1901	.....	5	5	13	8	16	16	16	16	17 $\frac{1}{2}$	17 $\frac{1}{2}$	11 $\frac{1}{2}$	14	7	7	7	7	7	7	156	Landabilis.
Fraenkel, Herman Fred. (1898) Fb. Ex. 1901	.....	13	13	13	8	13	13	13	13	24 $\frac{1}{2}$	24 $\frac{1}{2}$	16	15	15	15	15	15	15	9 $\frac{1}{2}$	191	Landabilis.
Fridericia, Louis Sigurd (1895) Fb. Ex. 1901	.....	13	13	16	16	16	16	16	16	29	29	11	13	13	13	13	13	13	14	210 $\frac{1}{2}$	Landabilis.
Guillard, Poul Robert Thanning Goldschmidt (1899) Fb. Ex. 1901	.....	16	13	16	13	16	16	16	16	29 $\frac{1}{2}$	29 $\frac{1}{2}$	11 $\frac{1}{2}$	13	13	13	13	13	13	13	184 $\frac{1}{2}$	Hand illand. 1.
Hansen, Adam Martin (1899) Fb. Ex. 1901	.....	8	8	8	16	8	16	8	8	18 $\frac{1}{2}$	18 $\frac{1}{2}$	13	6	13	13	13	13	13	8	151 $\frac{1}{2}$	Landabilis.
Hansen, Stephan Elis Agathon Horstmann (1895) Fb. Ex. 1901	.....	5	8	13	8	13	13	13	13	17 $\frac{1}{2}$	17 $\frac{1}{2}$	6	14	11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	9 $\frac{1}{2}$	159 $\frac{1}{2}$	Landabilis.