Study on High Invasibility of *Ulex europaeus*: What Induces the Invasiveness of *Ulex europaeus*?

Laboratory of Tropical Agriculture
Mika Hozawa
2020

Chapter I: General introduction

The target species of this study, *Ulex europaeus* L. is originated in Western Europe, and listed as world worst 100 noxious weed species because of its invasiveness. Once it is adapted to the new habitat and starts stable propagation, it is very difficult to control. It has caused negative effects on the environments and agriculture in its infested sites in the world from temperate to high elevation of subtropics and tropics. The objectives of this study were to elucidate its invasibility focused on its propagation ability from seeds and leaf allelopathy.

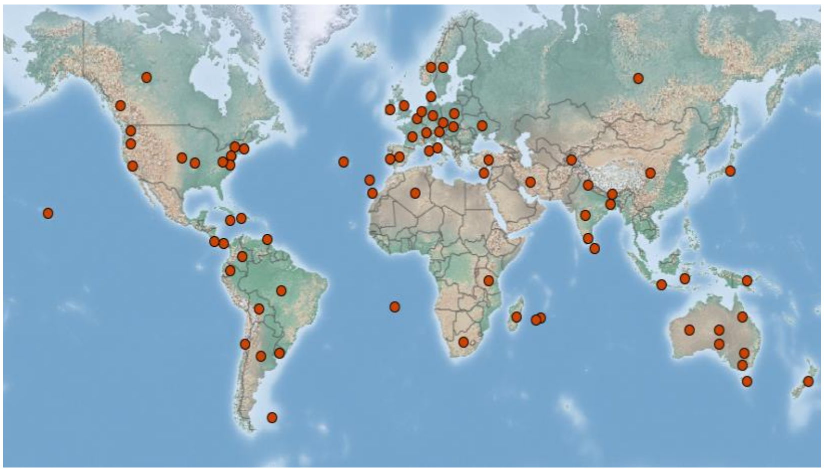

Fig. I-2 *U. europaeus* distribution in the world by Invasive Species Compendium, 2019.

Chapter II: Genetic research

The tissue samples of *U. europaeus* were scratched on FTA® Plant Card (Whatman® Co., Ltd.) from three regions, Hawaiian Archipelago (Hawaii Island and Maui Island), North America (California), and New Zealand (North and South Islands) for PCR, and they were compared by using microsatellite analyses. As a result, it was clarified that they were not genetically far.

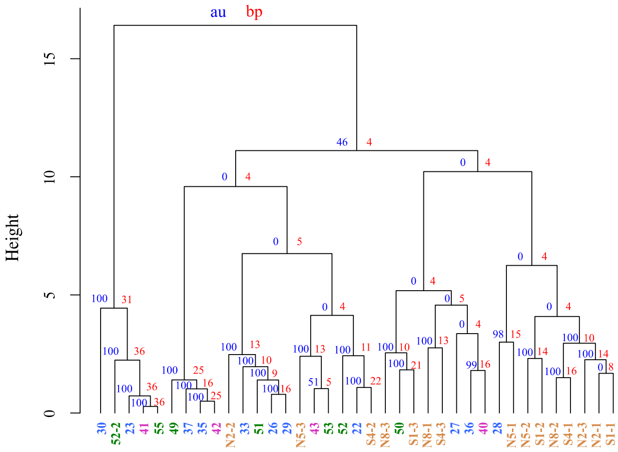

Fig. II-1 Dendrogram of *Ulex europaeus* sampled in Maui, California, Hawaii and New Zealand after 1000-boot strap. Blue: Maui, green: Hawaii, pink: California, yellow with N: New Zealand North Island, yellow with S: New Zealand Soutn Island. Au, bp are two types of p-values (%): au (approximately unbiased) p-value and bp (bootstrap probability) value.

Chapter III: Seed morphology

The seed length, dry mass, and pod length of the samples taken from three regions, Hawaiian Archipelago (Hawaii and Maui Islands), North America (California), and New Zealand (North and South Islands) were compared, and the relations with climatic factors at their growth were examined.

As a result, the seed morphology of *U. europaeus* were significantly different among populations and the relations with rainfall at their growth negatively affected the seed length and pod length significantly.

Table III-1 Mean (± s.e.) length and dry mass of *Ulex europaeus* seeds and pod length (± s.e.) within sampling locations. N. and S. mean North Island and South Island respectively. The letters in the same column indicate the significant differences ($p < 0.05$) of means using a post-hoc test of Tukey.

Location	Mean length (mm)	Mean dry mass(mg)	Mean pod length (mm)
Hawaii	2.54 ± 0.05 a	4.95 ± 0.28 a	14.11 ±1.06 a
Maui	2.63 ± 0.07 a	5.62 ± 0.20 a	14.99 ±1.41 b
California	3.57 ± 0.14 b	5.30 ± 0.44 a	
New Zealand N.	3.00 ± 0.05 c	5.92 ± 0.62 ab	15.65 ±2.93 bc
New Zealand S.	3.28 ± 0.15 b	7.55 ± 0.45 b	16.66 ±0.93 c

Chapter IV: Seed germination traits

The seed germination traits including germination rate and speed of the samples taken in three regions, Hawaiian Archipelago (Hawaii and Maui Islands), North

America (California), and New Zealand (North and South Islands) were compared, and the relations with climatic factors at their growth were examined.

As a result, germination rate and speed were significantly affected by temperature and rainfall at seed growth negatively. In addition to that, some preferable range for better germination rate and speed were suggested.

Table IV-3 Germination rate and speed of seeds taken from each mother tree. H: Hawaii Island, M: Maui Island, C: California, NN: New Zealand North Island, NS: New Zealand South Island, GR: Germination rate, GS: Germination speed. The unit of germination rate was %, that of germination speed was the reciprocal number of the days taken to be 50% of germination.

	H1	H2	H3	H4	M1	M2	M3	M4	C	NN1	NN2	NS1	NS2
GR1 (%)	100	100	10	80	100	100	100	60	40	30	40	80	100
GR2 (%)	90	100	30	30	90	90	60	40	40	20	70	70	90
Mean GR	95	100	20	55	95	95	80	50	40	25	55	75	95
GS1	0.063	0.1	0.034	0.063	0.067	0.083	0.067	0.063	0.034	0.034	0.034	0.04	0.125
GS2	0.048	0.125	0.034	0.034	0.083	0.1	0.067	0.034	0.034	0.034	0.048	0.048	0.1
Mean GS	0.056	0.113	0.034	0.049	0.075	0.092	0.067	0.049	0.034	0.034	0.041	0.044	0.113

Chapter V: Allelopathic effects

Allelopathic effects of *U. eurpaeus* leaves were tested on the seed germination of *U. europaeus* itself and other species. The allelopathic effects of the leaf litter leachates of *U. europaeus* were comparatively strong among other weedy species, and different among sampling habitats significantly.

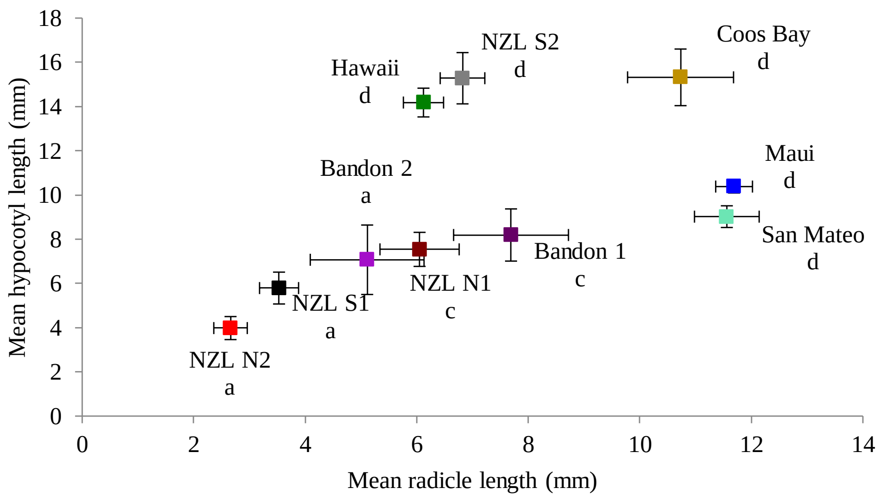

Fig. V-3 Mean length of the hypocotyls and radicles of the lettuce tested on the leaf litter leachates of *U. europaeus*. The bars represent standard error and the different letters under the site names indicate statistical differences at 5% level.

In addition, the leaf leachates of *U. europaeus* significantly hindered the seed germination of *U. europaeus* itself.

Chapter VI: General discussion and conclusion

U. europaeus sampled for this study has invaded and successfully adapted to the sampling sites in Hawaiian Archipelago (Hawaii and Maui Islands), North America (California), and New Zealand (North and South Islands). They were genetically very close, and the seeds showed morphological differences significantly among populations. It inferred their phenotypic plasticity to adapt themselves to the new environments. Though the seeds showed the preferable climatic conditions for better germination, *U. europaeus* has adapted itself to the new environments by using their variability and excluding other species and protecting its seed production ability by using allelopathic effects of the leaves.