

Application of seaweeds in aquaculture

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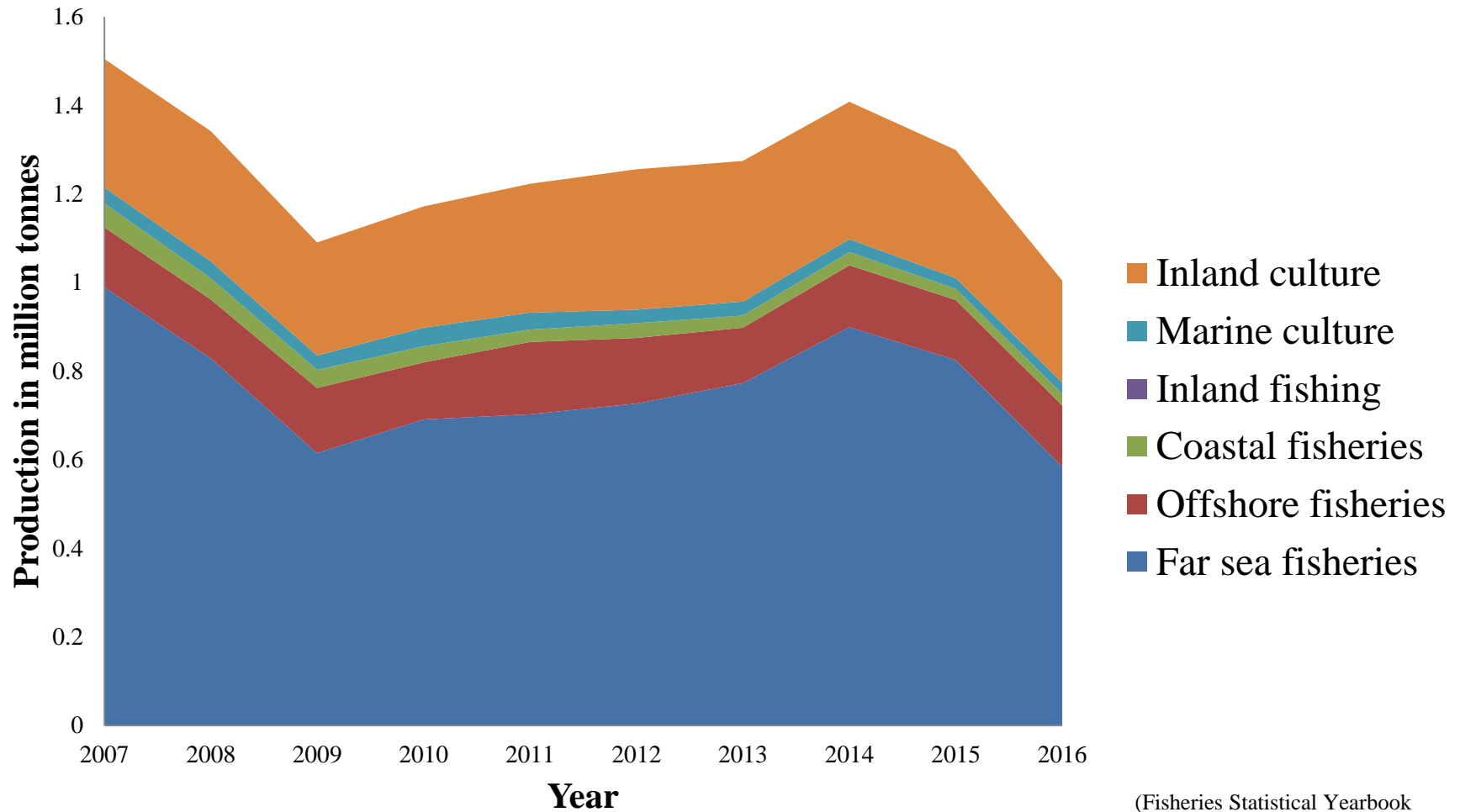
- fisheries and aquaculture production
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- domestic and international trades

Seaweed research and application

- seaweed resources of Taiwan
- *Gracilaria* in small abalone aquaculture
- seaweeds in sea cucumber aquaculture
- seaweeds in marine fish aquaculture
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Fisheries and aquaculture production in million tonnes, 2007-2016

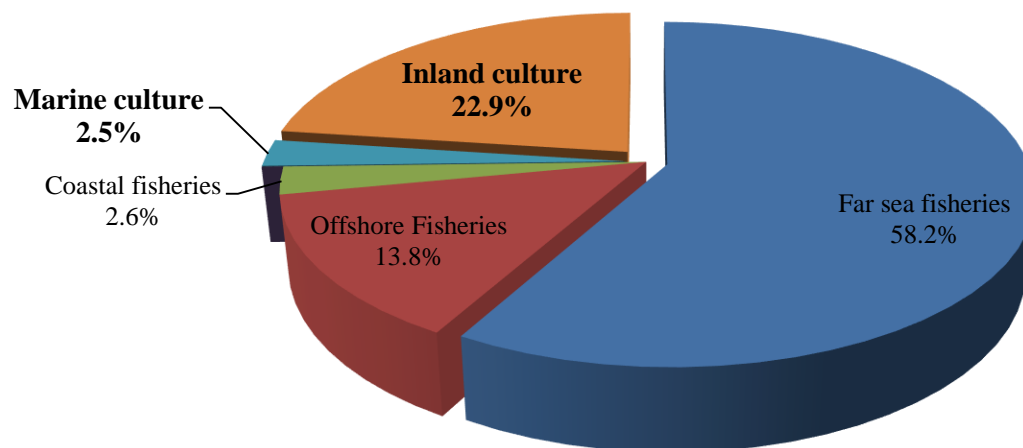


(Fisheries Statistical Yearbook
Taiwan, Kinmen and Matsu Area, 2016)



Fisheries and aquaculture production in percentage, 2016

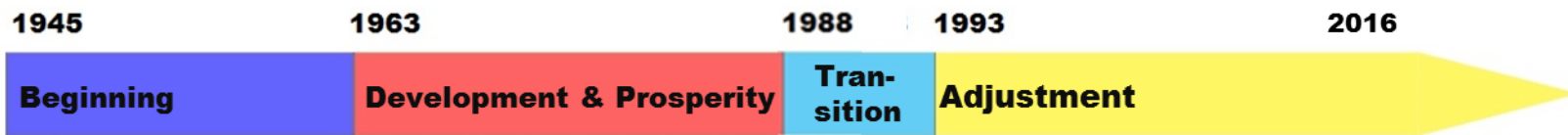
- Inland culture provides the 2nd largest production
- Aquaculture production together accounts for 25% of the total production



(Fisheries Statistical Yearbook
Taiwan, Kinmen and Matsu Area, 2016)



Development of aquaculture in Taiwan

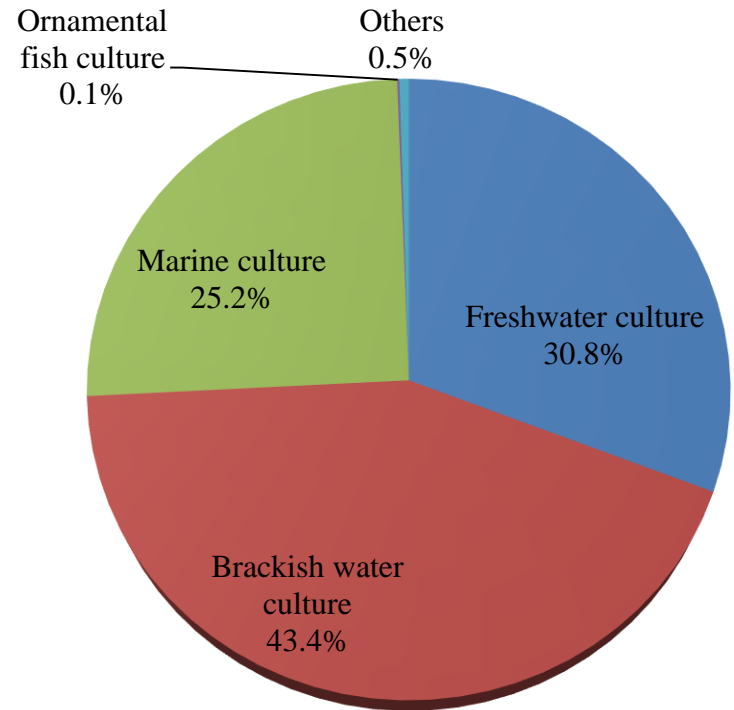


	1945	1963	1988	1993	2016
Production in thousand tonnes	46	50	300	285	255
Forms	extensive	semi- & intensive		super- & intensive, cage, sea ranching	
	supply of local needs	development of spawning and rearing techniques	disease, environmental issues	effective usage of resources, improvement of culture environments, new species, automatic & business management	



Aquaculture areas in 2016

Type of culture	Areas in hectares (ha)
Inland culture	
Brackish water culture	19640.88
Freshwater culture	13904.67
Others	220.10
Ornamental fish culture	54.73
Marine culture	11393.23
<i>Cage culture</i>	<i>*296616 m³</i>



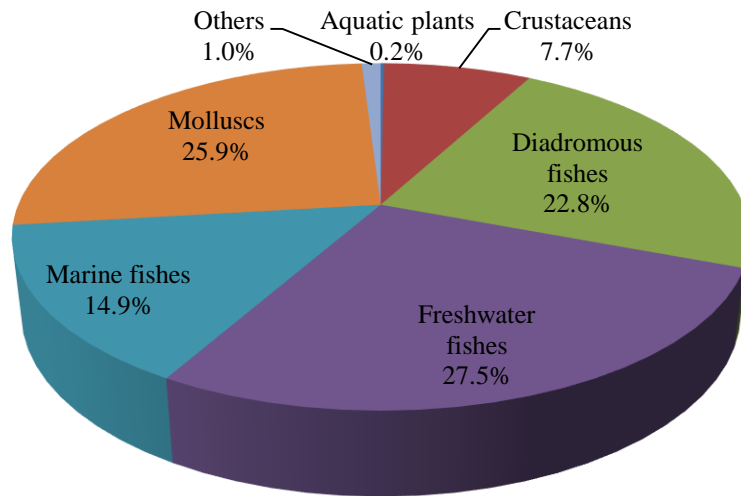
*Excluding cage culture

(Fisheries Statistical Yearbook
Taiwan, Kinmen and Matsu Area, 2016)



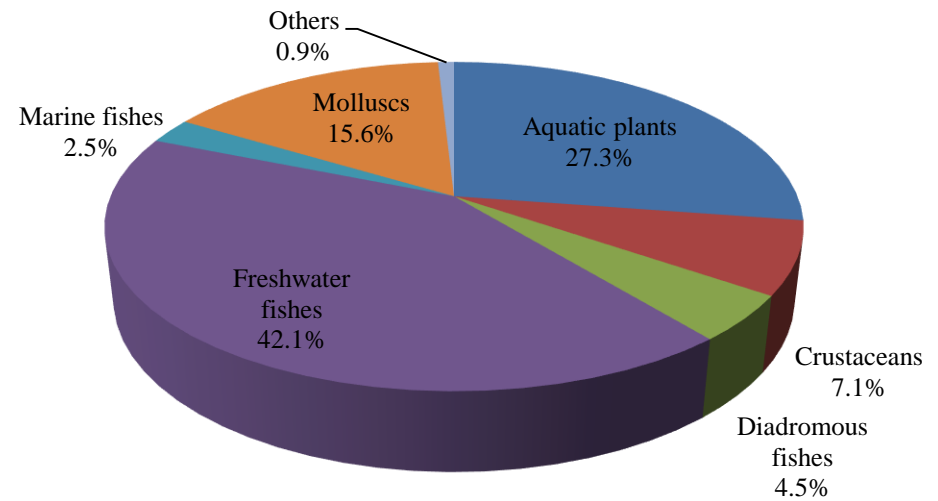
Aquaculture production by species groups in 2016

Taiwan



- Fish (65%) is the major species group
- Aquatic plants = 0.2%

World



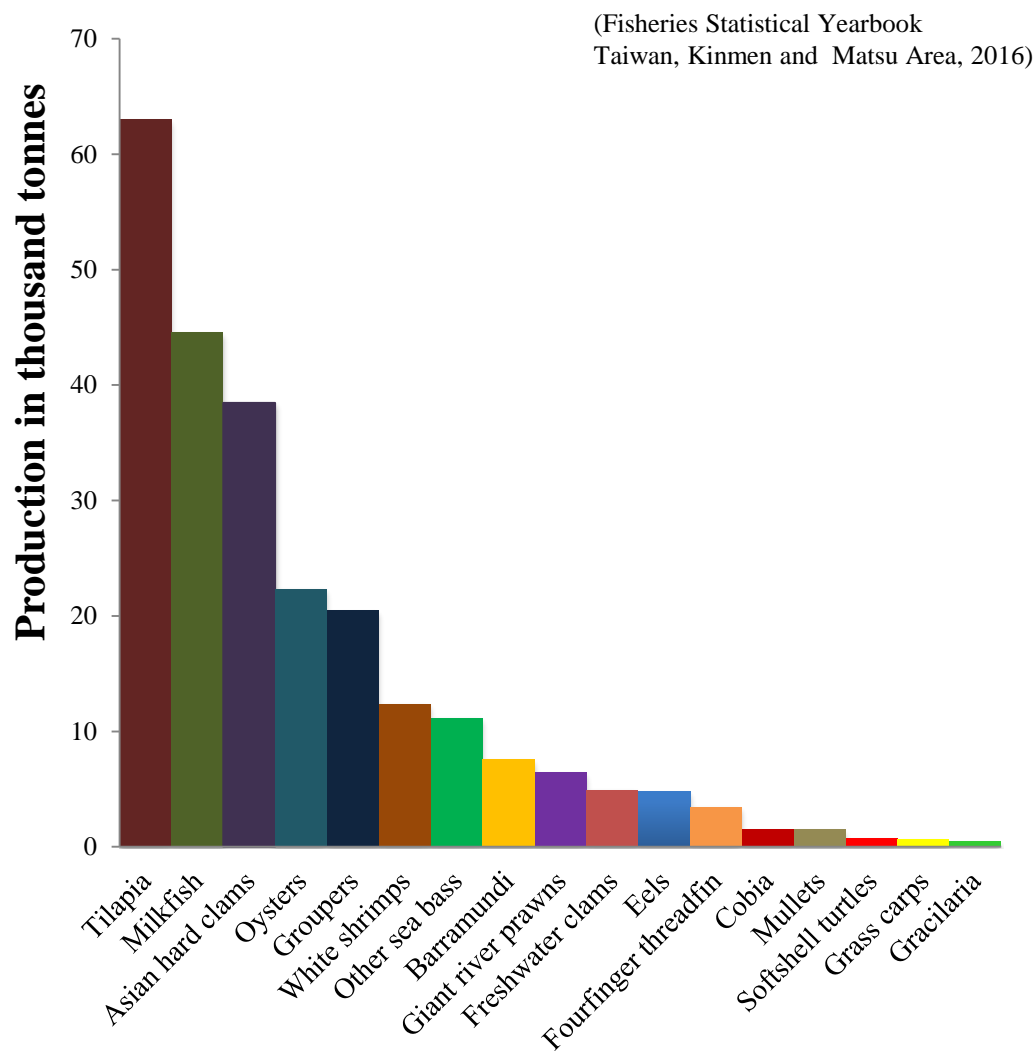
- Fish < 50%
- Aquatic plants > 25%

(FAO Dataset: Global Aquaculture Production)



Major aquaculture species in 2016

Species	Production (t)
Tilapia	63028
Milkfish	44548
Asian hard clams	38447
Oysters	22339
Groupers	20479
White shrimps	12376
Sea bass	11187
Barramundi	7554
Giant river prawns	6437
Freshwater clams	4915
Eels	4812
Fourfinger threadfin	3434
Cobia	1515
Mulletts	1511
Softshell turtles	723
Grass carps	660
<i>Gracilaria</i>	450



Domestic trades of aquaculture products



1. Auction markets
2. Traditional markets
3. Supermarkets, discount stores
4. Sightseeing fish markets
5. E-commerce



Exports of aquaculture products in 2016

Main importers: Japan, U.S.A., South Korea, European Union, Middle East and Mainland China

Aquaculture products	Value (thousand US\$)
Fish	
Groupers	97584
Eels	69091
Sea Bass	45966
Milkfish	21675
Seaweeds	
Sea laver	1896
Mucilages	1049
<i>Laminaria</i> seaweeds	370

(Fisheries Statistical Yearbook
Taiwan, Kinmen and Matsu Area, 2016)

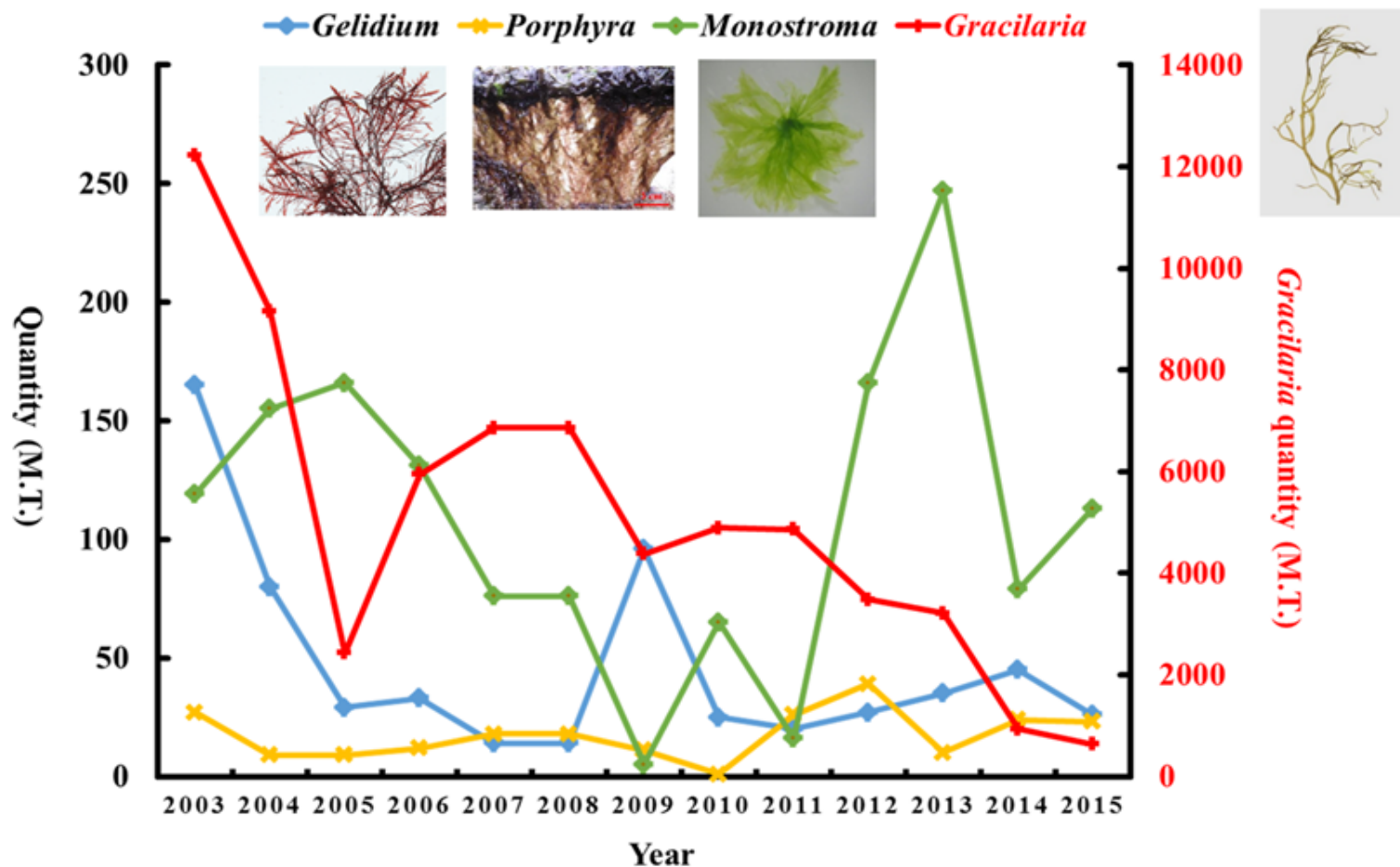


Cultivation of seaweeds in Taiwan

- *Gracilaria*
- *Porphyra*
- *Caulerpa* (sea grape)
- *Laminaria*
- *Undaria*
- *Ulva*
- *Sarcodia*
- *Agardhiella subulata*



The annual quantities of four main kinds of edible seaweeds in Taiwan



- The increase in labor costs results in reduced seaweed production
- Imported, instead of local, seaweeds are used



Application of *Gracilaria* in small abalone aquaculture



Gracilaria tenuistipitata

- Although many species of seaweed could be used as feed, only *Gracilaria* meet the supply requirements at a low price
- Almost all of the small abalone farms use *Gracilaria* as the main feed

Haliotis diversicolor
Small abalone
Taiwanese abalone



Application of *Gracilaria* in small abalone aquaculture



- In Taiwan, *Gracilaria* could be cultured in ponds
- Fishermen need to stir the thalli in planting ponds every day



Application of *Gracilaria* in small abalone aquaculture



- Abalone culture ponds in the intertidal zone: *Gracilaria* thalli could be thrown and spread by pump



Application of seaweeds in sea cucumber aquaculture



Ulva lactuca



Gracilaria tenuistipitata



Laminaria japonica



Apostichopus japonicus



Application of seaweeds in largescale blackfish aquaculture



Captive breeding and rearing, and the effect of different macroalgae and dietary protein levels on juvenile growth of largescale blackfish, *Girella punctata*

Huang, Tzu-Yu Amy

Thesis supervisor: **Prof. Nan, Fan-Hua**

Department of Aquaculture



Distribution of largescale blackfish

Order Perciformes

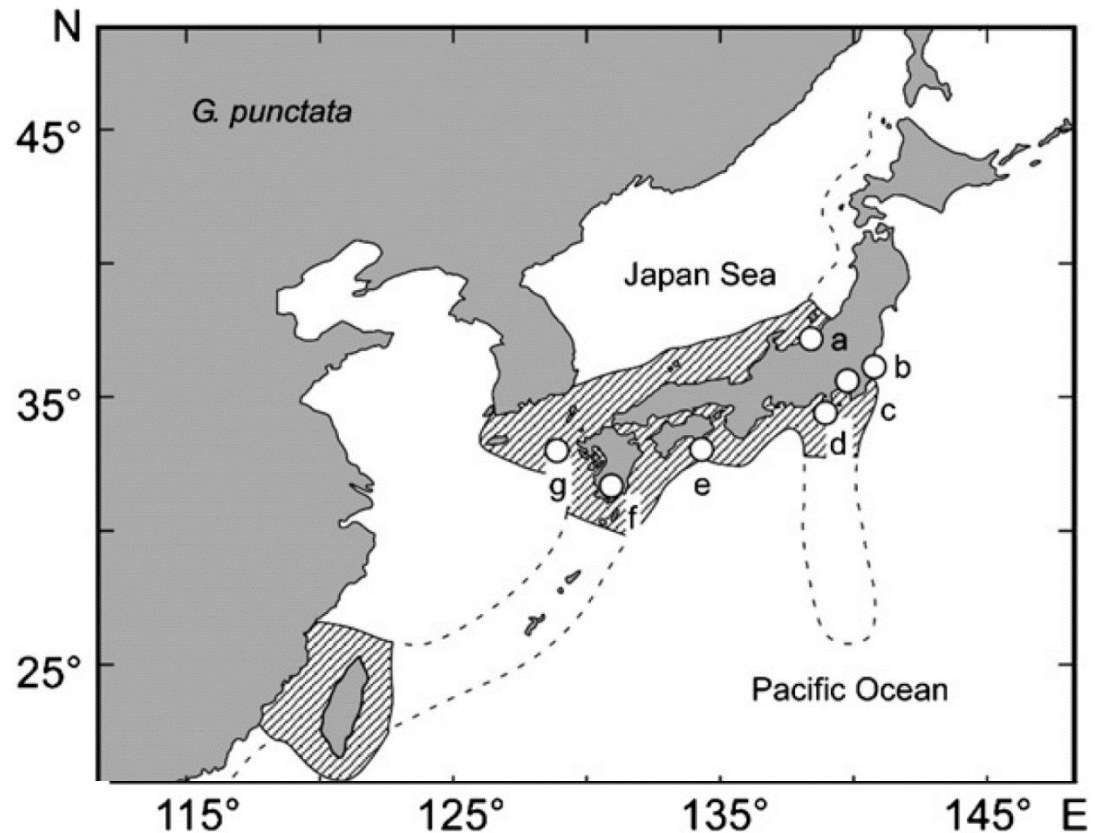
Family Kyphosidae

Genus *Girella*

Girella punctata (Gray, 1835)

Largescale Blackfish

- Principal distribution areas enclosed by solid lines and obliquely shaded, additional areas enclosed by broken lines



Adapted from: Itoi *et al.* (2007) *Organisms Diversity & Evolution*, 7:12–19.



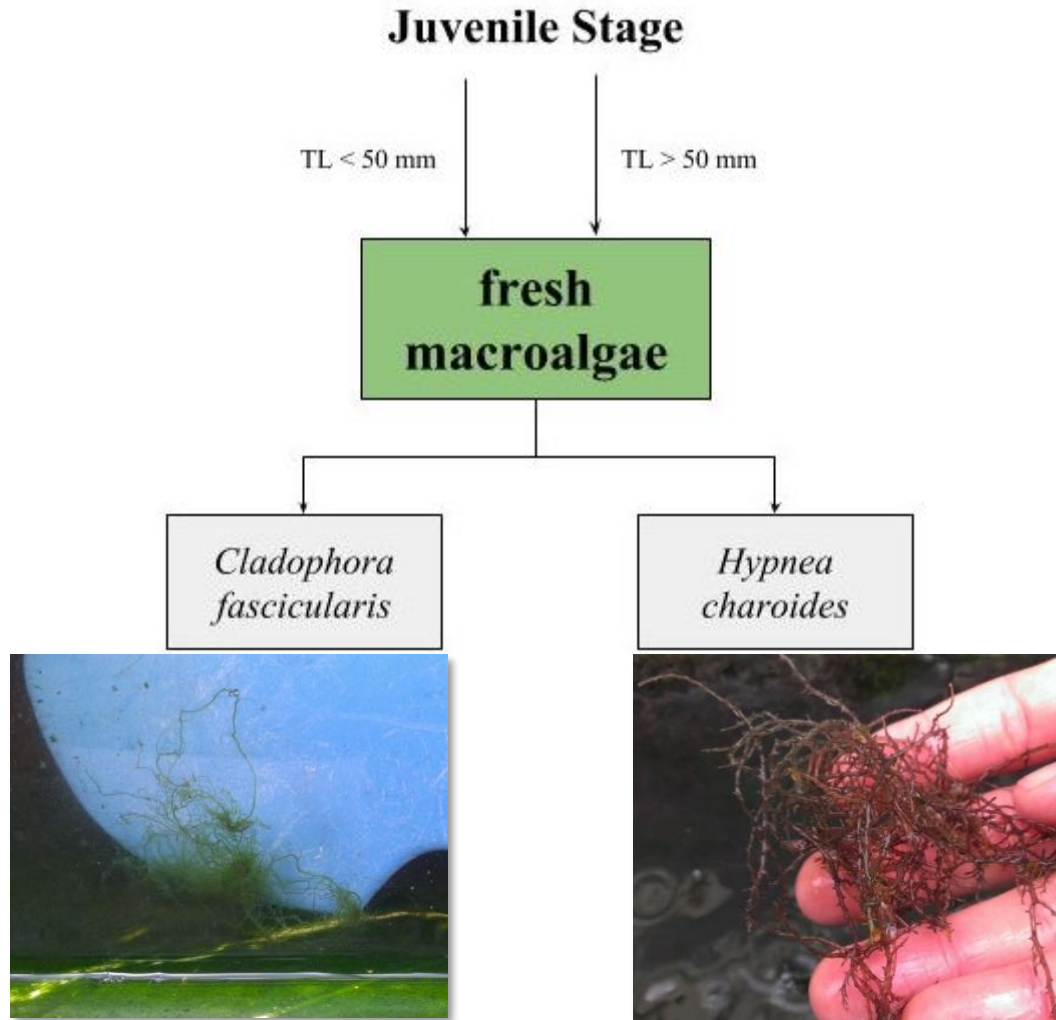
Macroalgae in diet





- Local, cold-resistant and algae-eating
- As the fish grow, the herbivorous content in their diets also increases
- *Girella* sp. feed on filamentous green and red algae (Clements and Choat, 1997)



Experimental design



Proximate composition of *Cladophora fascicularis* and *Hypnea charoides*

	<i>Cladophora fascicularis</i>		<i>Hypnea charoides</i>		Artificial feed
					
	wet	dry	wet	dry	p30
Moisture	82.24	1.69	94.96	3.03	8.32
Crude protein	8.33	42.78	1.89	30.54	29.13
Crude lipid	4.05	5.50	2.14	4.21	9.41
Crude fiber	1.61	7.33	1.49	5.26	8.61
Ash	1.84	19.58	0.90	33.80	10.26



Growth performance of *Girella punctata* juvenile fed fresh macroalgae for 8 weeks

	Juveniles TL < 50 mm			Juveniles TL > 50 mm		
	<i>Cladophora fascicularis</i>	<i>Hypnea charoides</i>	p30	<i>Cladophora fascicularis</i>	<i>Hypnea charoides</i>	p30
Initial length (mm)	42.98±0.05	40.37±1.36	45.89±0.41	51.44±0.43	52.09±1.50	53.45±0.80
Initial weight (g)	1.10±0.02	1.01±0.03	1.60±0.04	1.99±0.03	1.93±0.10	2.53±0.08
Final length (mm)	46.66±0.68 ^a	41.76±0.25 ^b	57.06±0.77	55.67±0.50	53.60±2.01	66.72±1.26
Final weight (g)	1.68±0.08 ^a	0.96±0.01 ^b	3.18±0.14	3.12±0.19 ^a	1.89±0.12 ^b	5.23±0.14
Weight gain (%)	47.67±4.49 ^a	-4.35±0.36 ^b	92.18±2.85	52.32±2.79 ^a	-1.93±0.08 ^b	103.73±2.77
SGR (%)	0.66±0.06^a	-0.10±0.01 ^b	1.14±0.03	0.69±0.01^a	-0.04±0.01 ^b	1.25±0.03
FI	4.20±0.01	4.00±0.50	2.56±0.25	6.90±0.01	6.30±0.30	4.48±0.07
FCR	10.92±1.41^a	-19.03±0.16 ^b	1.62±0.06	10.07±2.76^a	-38.76±8.34 ^b	1.66±0.01
PER	1.12±0.14^a	-2.78±0.02 ^b	2.31±0.08	1.29±0.35^a	-1.43±0.31 ^b	2.26±0.01
Survival (%)	90	90	100	100	90	100



Conclusion

- Largescale blackfish juveniles fed *Cladophora fascicularis* had better growth performance than those ones fed *Hypnea charoides*
- Largescale blackfish juveniles > 50 mm utilized *Cladophora fascicularis* more effectively than juveniles < 50 mm.



Application of seaweeds in poultry & swine diets



Sargassum cristaefolium



Monostroma nitidum

- In Taiwan, the company “TAN HOU OCEAN DEVELOPMENT CO. LTD” prepare artificial feed with seaweed powder, *Sargassum* and *Monostroma*, for chicken and pig
- Company’s personnel believe that chicken and pig eat the feed with seaweed powder, which makes animals healthier since the meat contains more ω -3 PUFA



Application of seaweeds in poultry & swine diets



Sargassum cristaefolium



Monostroma nitidum



Omega Chicken™



Omega Pork™



Benefits of seaweeds in animal production processes

- As nutritional supplements, provide vitamins and minerals
- As natural antioxidants, neutralize the free radicals *in vivo*, while protecting the ingredients in the feed
- Regulate the immune system and prevent pathogens
- Increase intestinal motility and help defecation
- As prebiotic, increase probiotic activity and improve intestinal health



Pet biscuits for dogs and cats





**Thank you
for your attention**

