Horizontal and vertical distribution of jellyfish, *Aurelia aurita* medusae, and estimation of its abundance using underwater video system in Tokyo Bay

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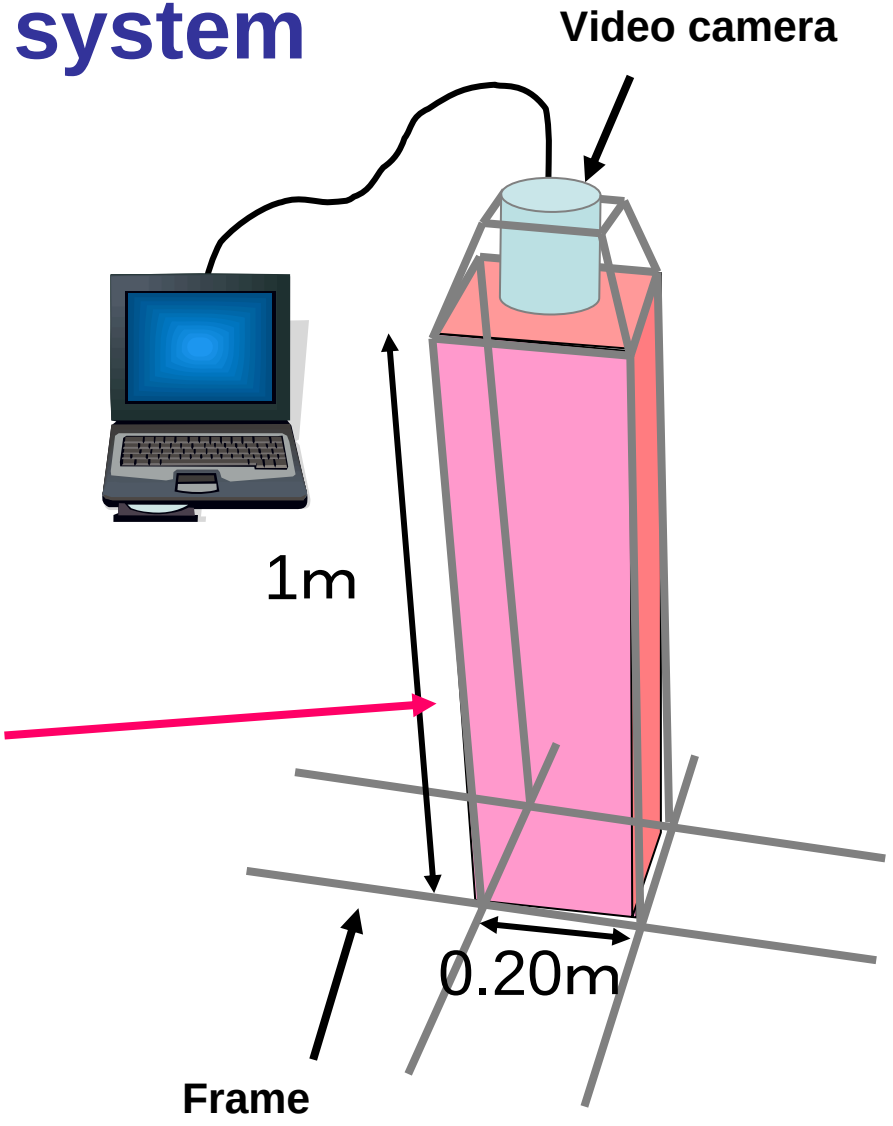
Underwater video system

1. We can get the fine data regarding the distribution and the size of organisms.
2. We can get the continuous distribution data.
3. We can observe in situ behavior of organisms in the water.
4. We can get the quantitative data of the population density.



Aims of this study

We conducted continuous survey throughout day and night in the innermost part of Tokyo Bay

1. **Observation of *A. aurita* medusae**
2. **Oceanographic analyses**

1. **Horizontal distribution of *Aurelia aurita* medusae**
2. **Diel vertical migration of *A. aurita* medusae**
3. **Size frequency distribution of medusae in each depth layer**
4. **Estimation of density and biomass of *A. aurita* medusae**
5. **Estimation of feeding impact of *A. aurita* medusae on zooplankton community**

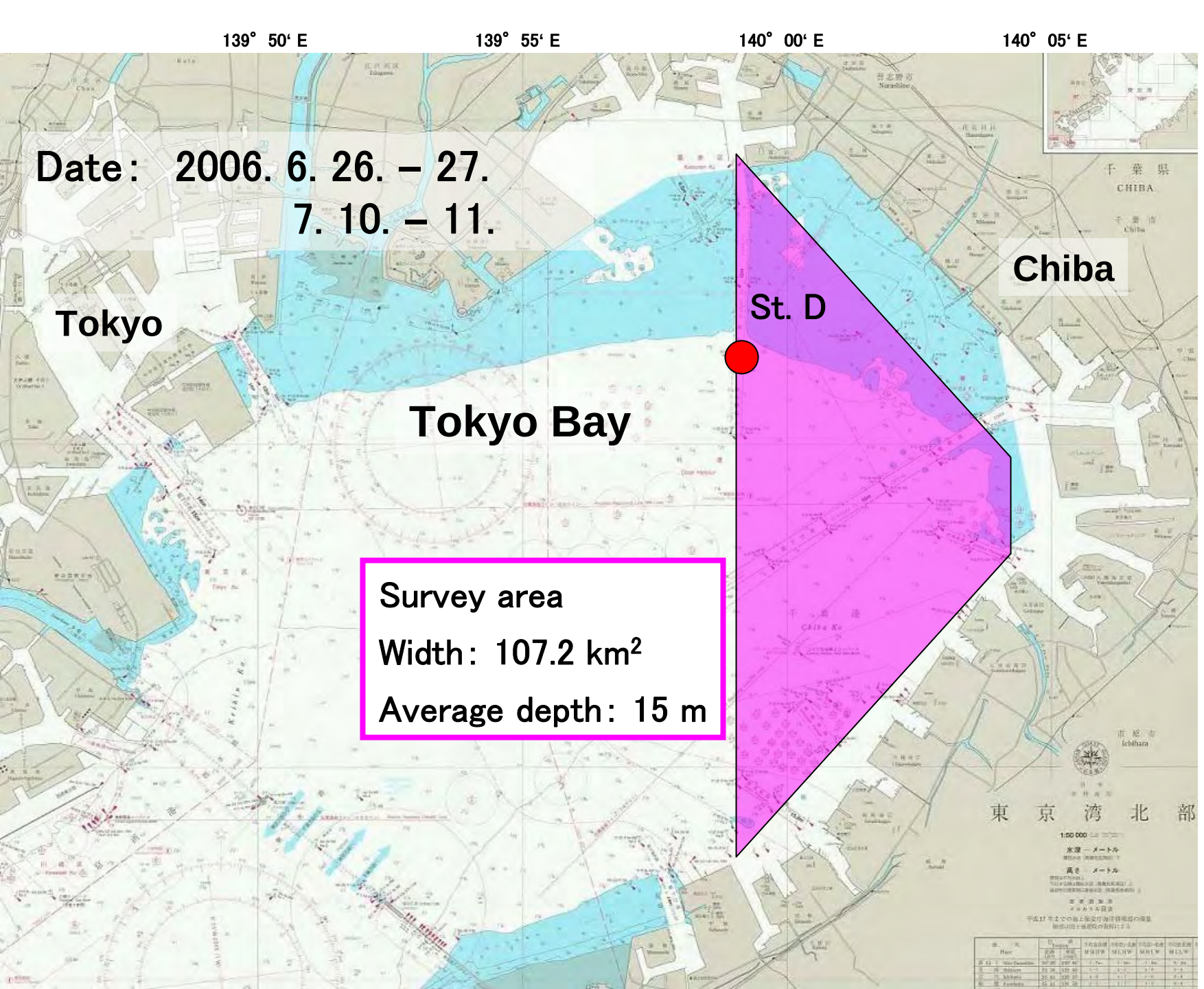
Methods

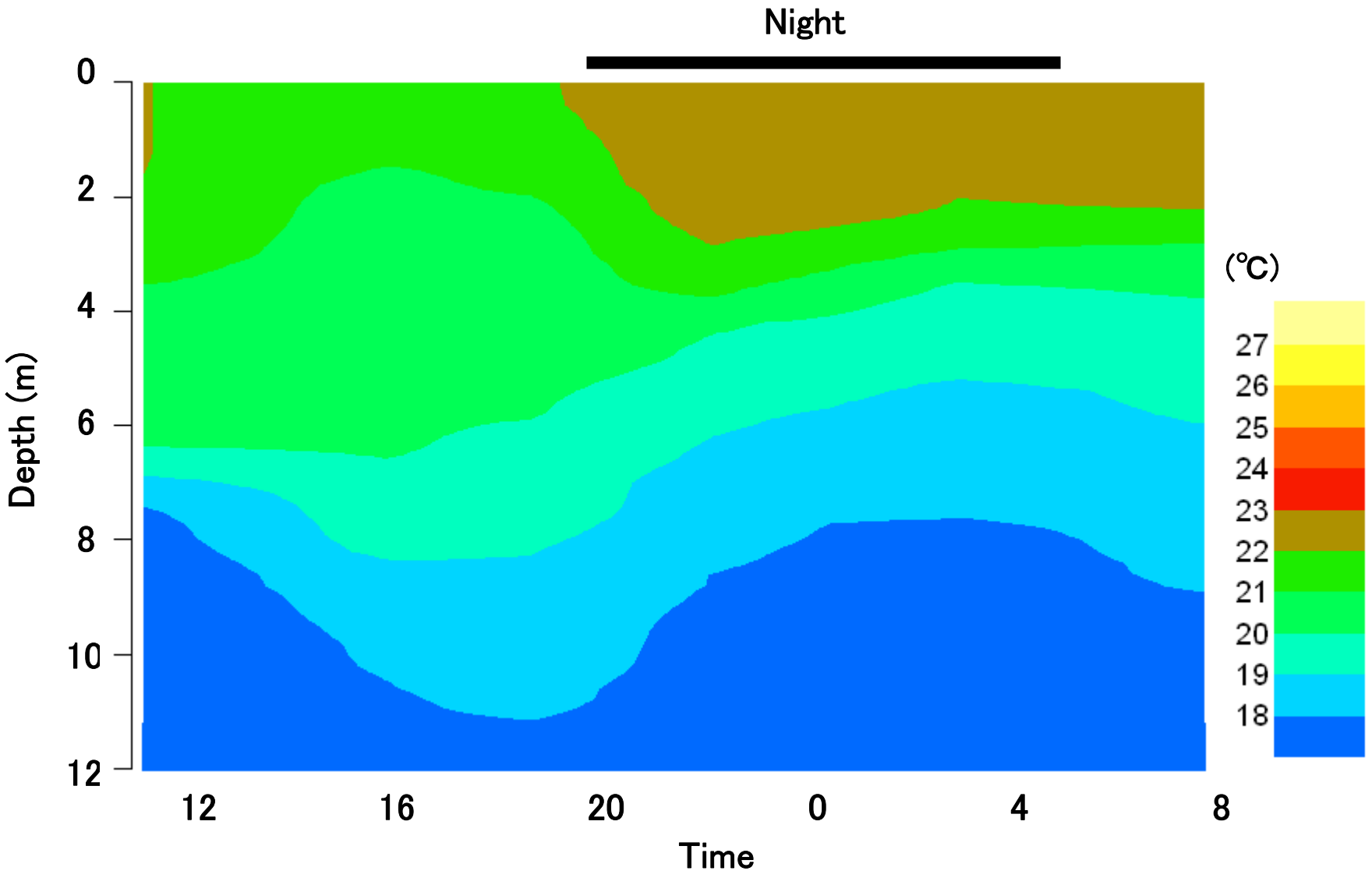
Observation of *A. aurita* medusae

1. **Observation by eye → Size and density of surface aggregation**
2. **Echo sounder → Vertical distribution of medusae**
3. **Underwater video system (Tsukamoto WT-7000)**
   → Vertical distribution, density and bell diameter of medusae

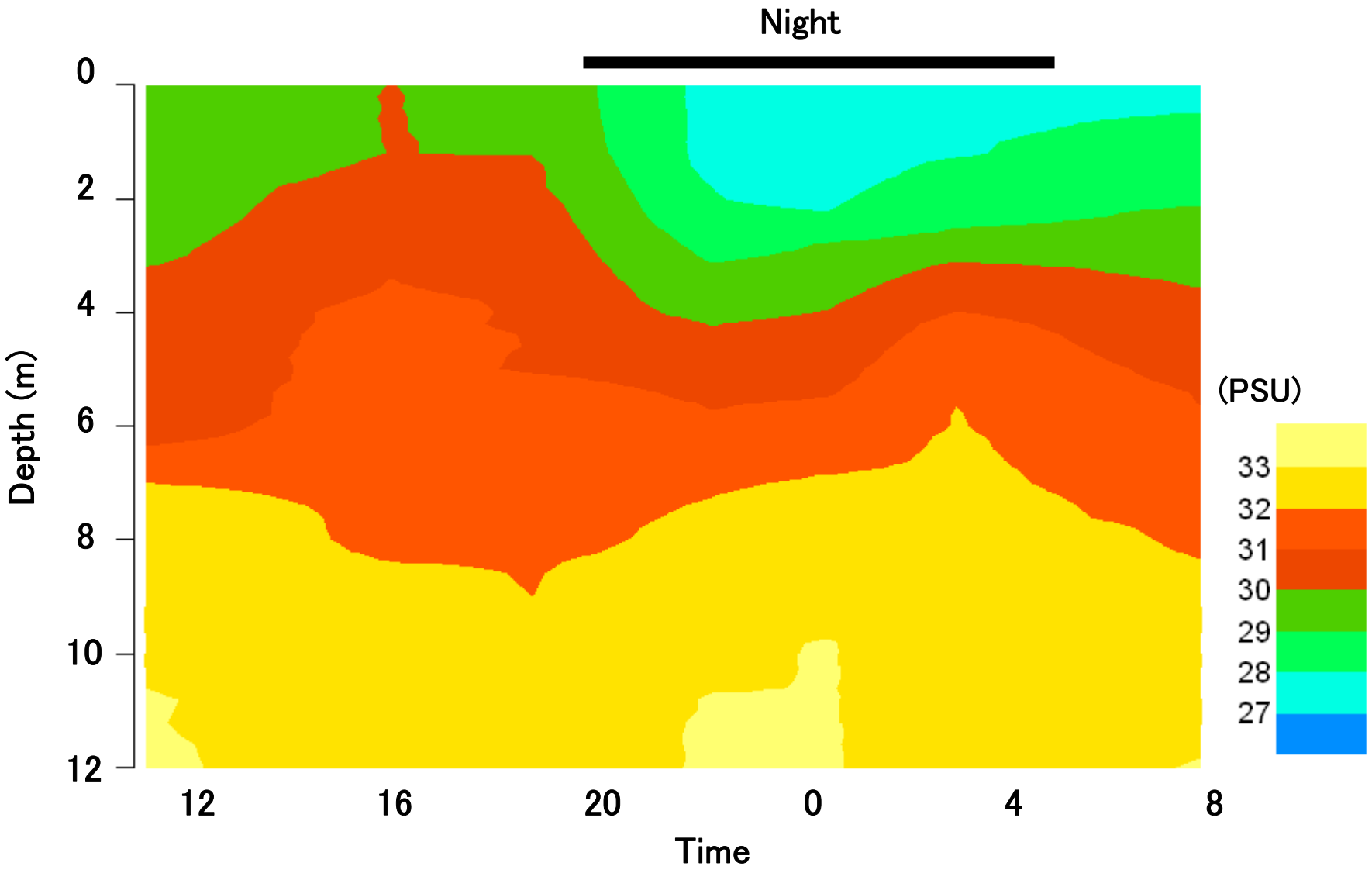
Oceanographic analyses

- **CTD analyses (Alec., AST-1000s)**
- **Dissolved oxygen concentration (Richard Brancker, XR – 420)**
- **Underwater quantum (LI-COR, 193SA)**
- **Chlorophyll concentration ()**
- **Zooplankton biomass (Water bottle and NORPAC Net sampling)**

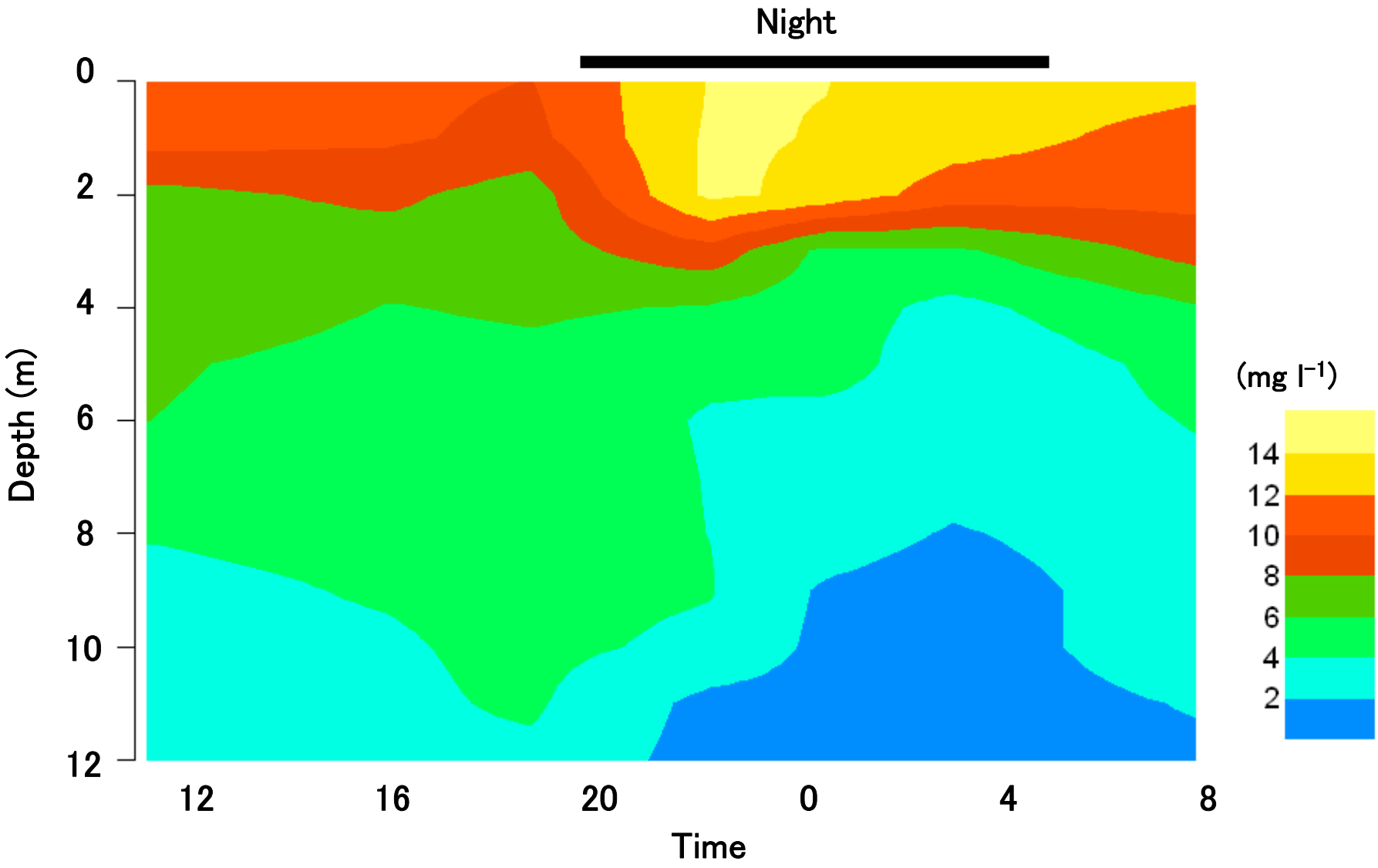

139° 50' E
139° 55' E
140° 00' E
140° 05' E
35° 40' N
35° 35' N
35° 30' N
Date: 2006. 6. 26. – 27.
7. 10. – 11.
Tokyo
Chiba
St. D
Tokyo Bay
Survey area
Width: 107.2 km²
Average depth: 15 m
CHIBA
東京湾北部



Water temperature (2006.6.26 – 27)

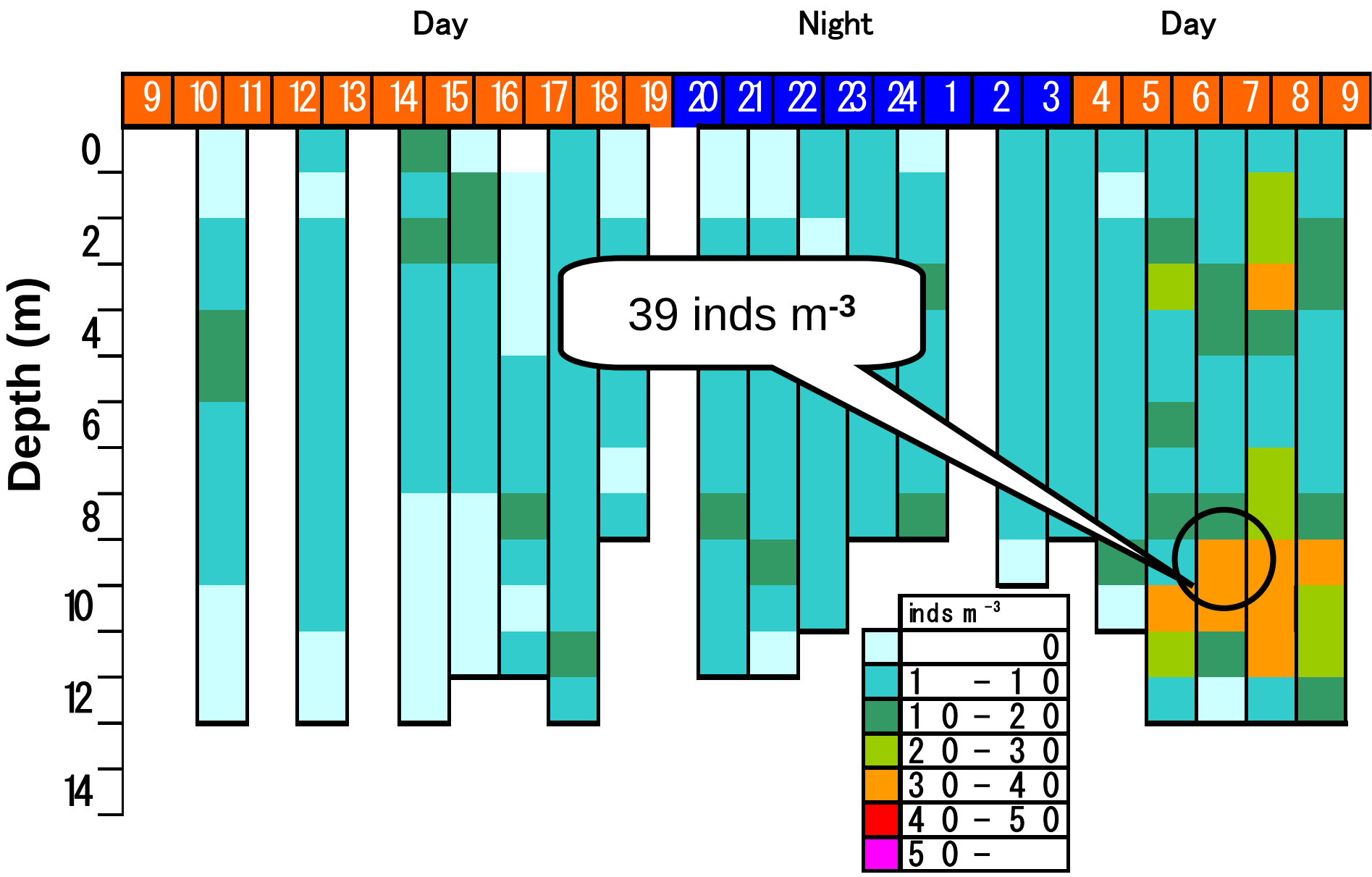


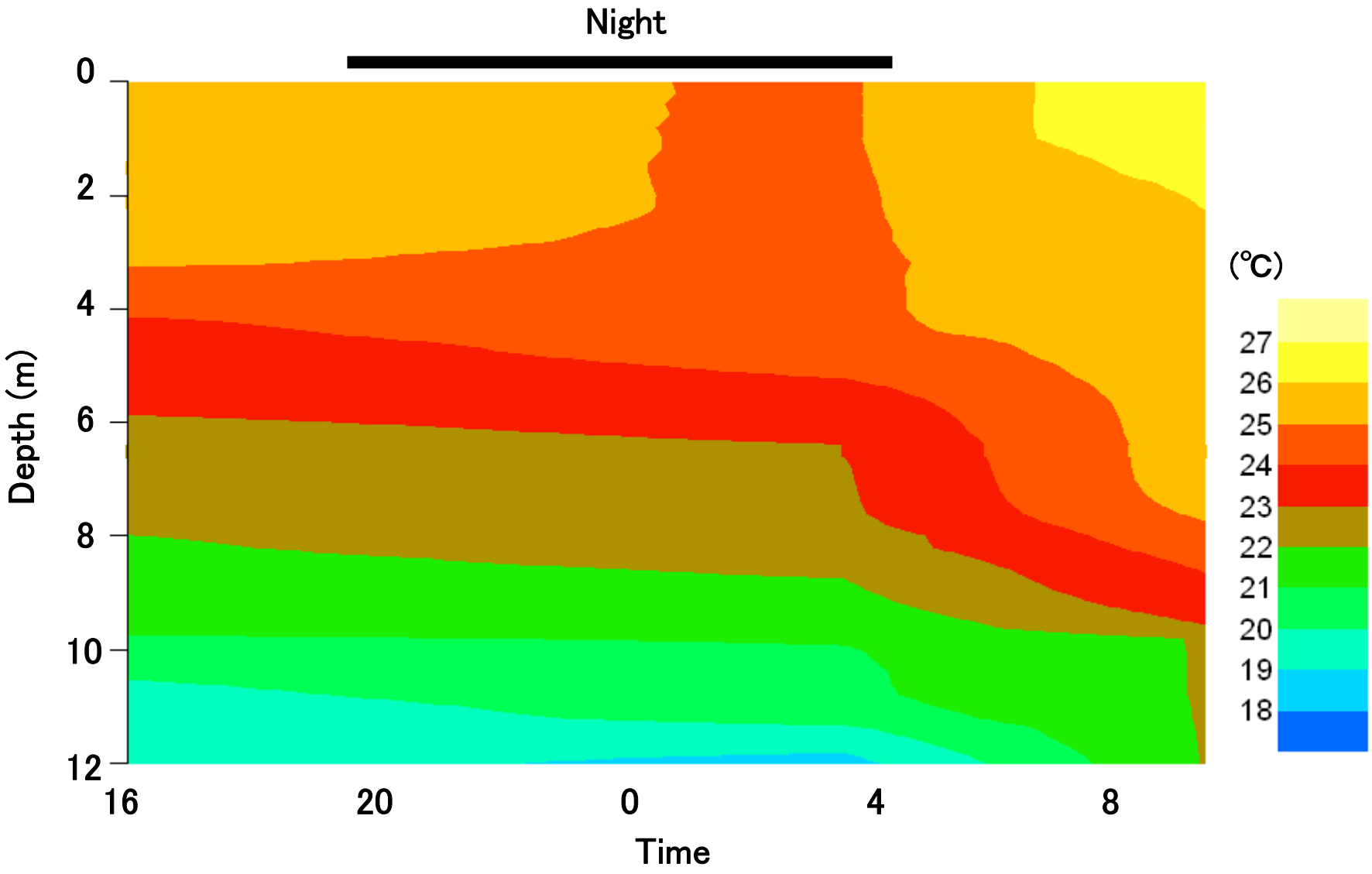
Salinity (2006.6.26 – 27)



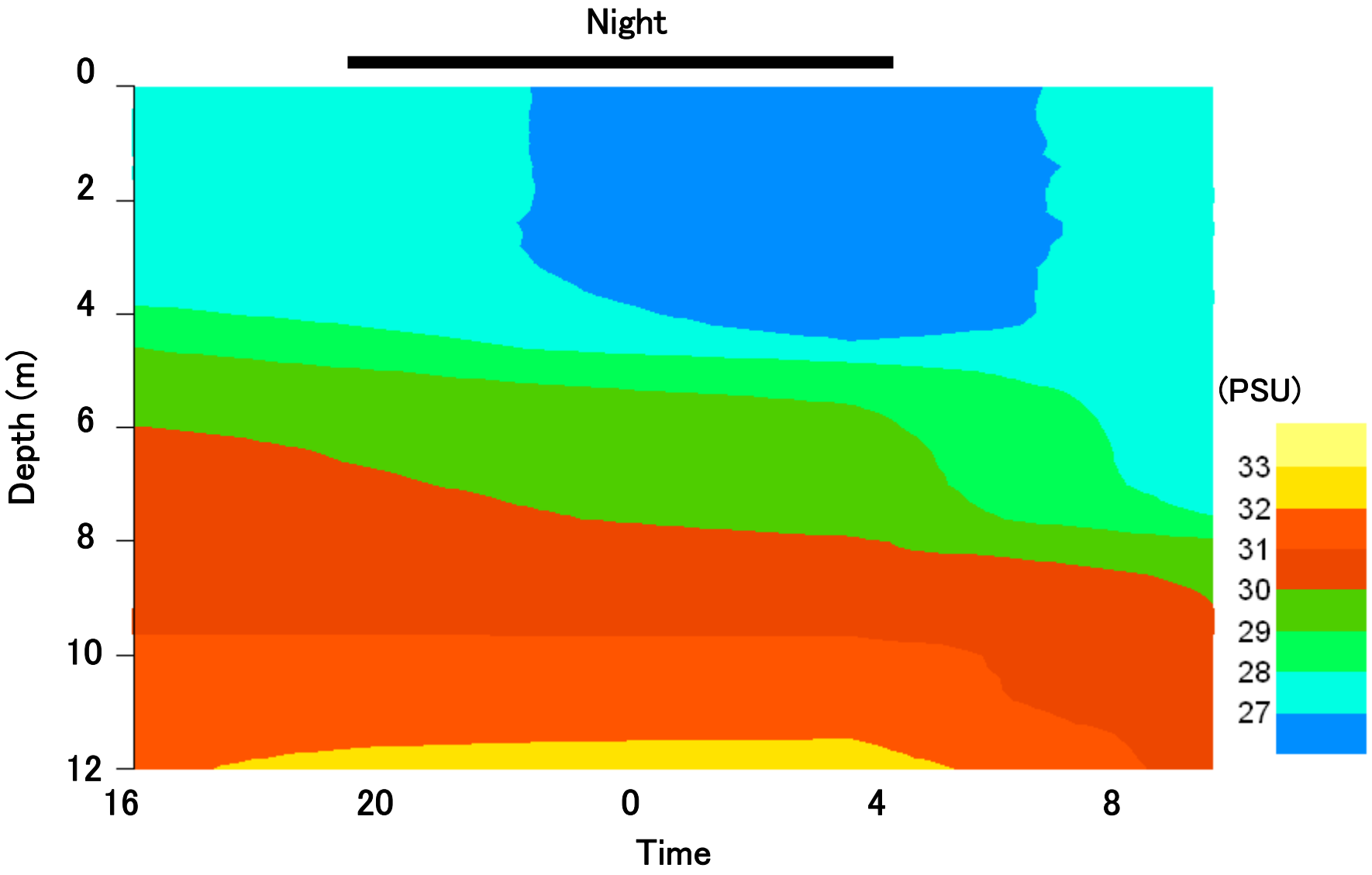
Dissolved oxygen concentration (2006.6.26 – 27)

Number of *A. aurita* medusae in each depth layer (2006. 6. 26 – 27.)

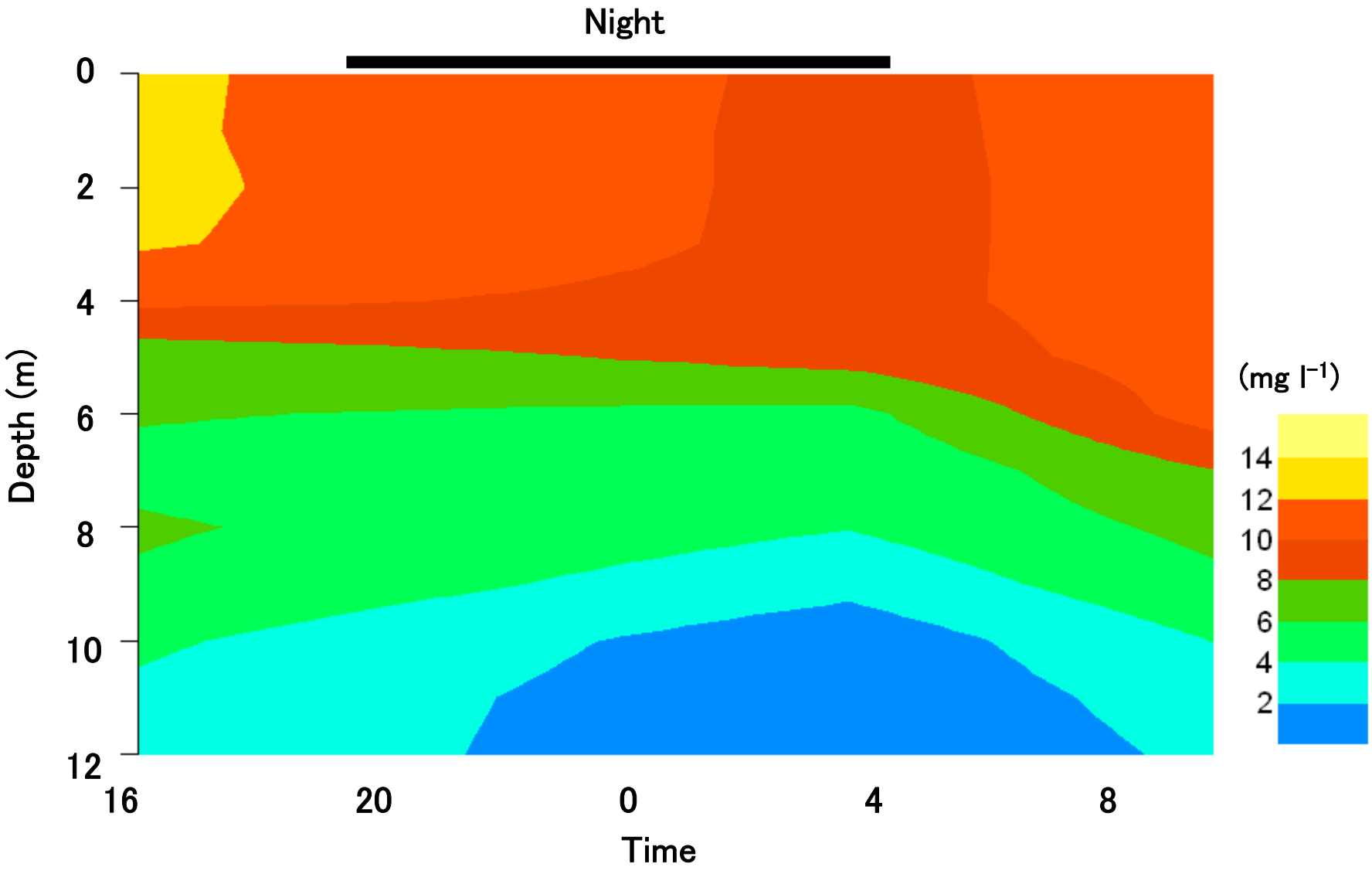




Temperature (2006.7.10 – 11)

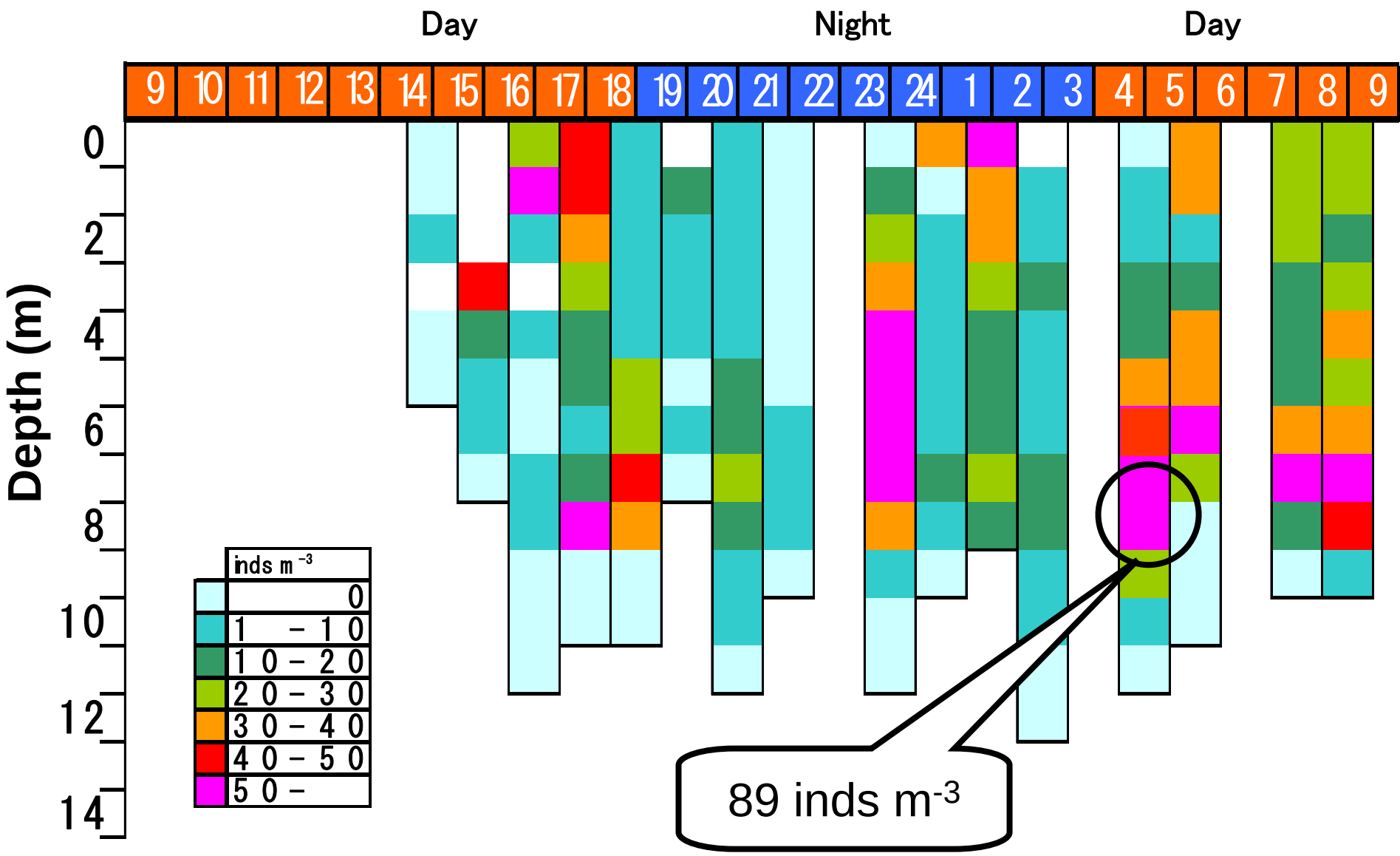


Salinity (2006.7.10 – 11)



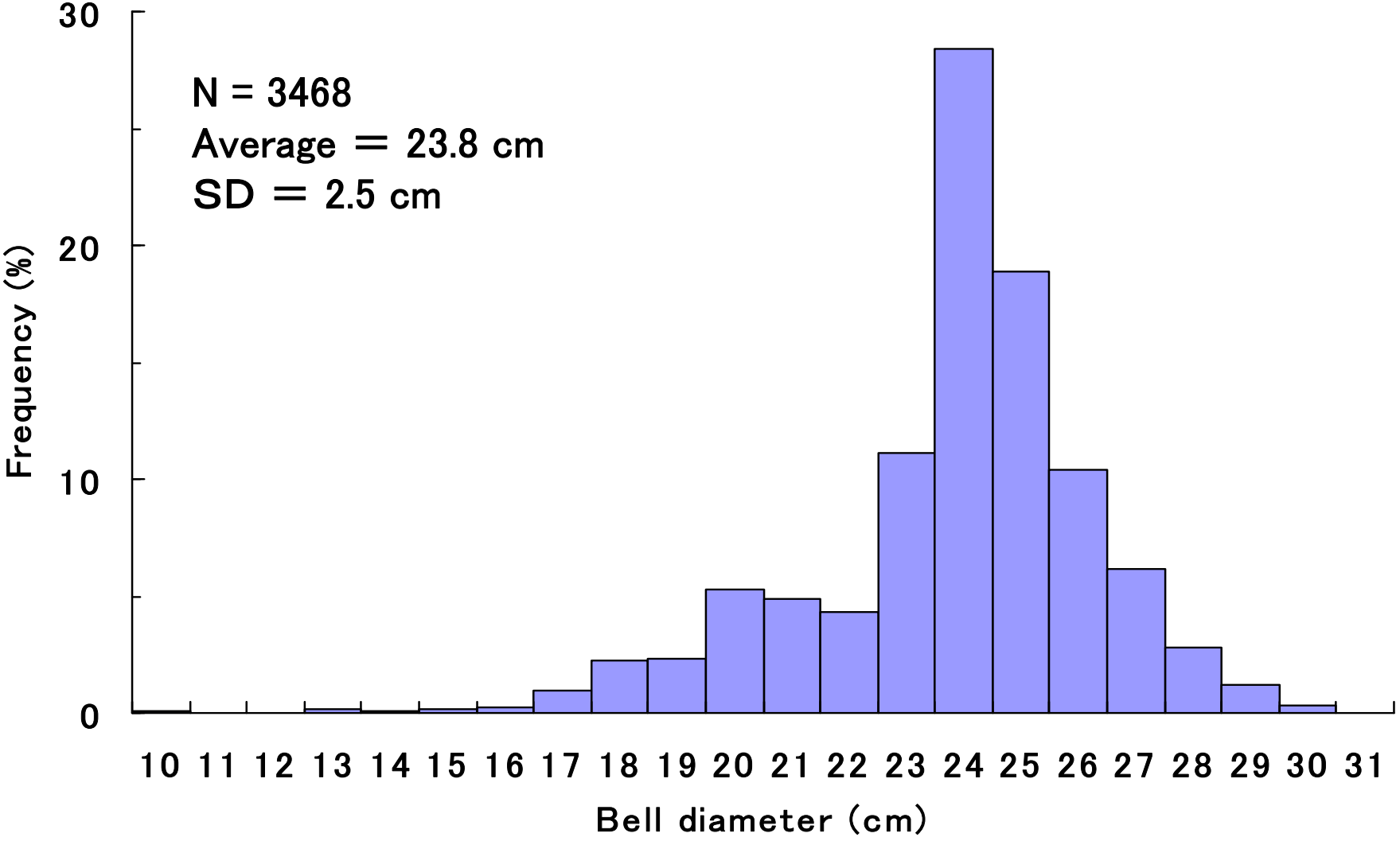
Dissolved oxygen concentration (2006.7.10 – 11)

Number of *A. aurita* medusae in each depth layer (2006. 7. 10 – 11.)



Significant difference in the bell diameter among the depths was not observed ＜ANOVA＞

Depth (m)	N	Total	Mean (cm)	SD (cm)
1	107	2580	24.11	4.06
2	163	3874	23.77	5.14
3	224	5433	24.25	5.03
4	328	7926	24.16	5.28
5	343	8199	23.90	5.36
6	294	6992	23.78	6.62
7	213	5014	23.54	7.16
8	235	5521	23.49	8.61
9	365	8679	23.78	8.23
10	471	11181	23.74	5.98
11	442	10520	23.80	6.40
12	233	5539	23.77	3.69
13	50	1204	24.08	3.67



Frequency distribution in the bell diameter of *A. aurita* medusae

Estimation of the density and the biomass of medusae in the survey area

Number of medusae in the surface aggregation: Estimated by eye based on the scale in the part of the ship body

Observation depth by eye: Estimated using the medusae attached disc

→ Density (inds m^{-3})

Width of the surface aggregation: Continuous measurement by GPS in the boarder line of the aggregation

Depth of the surface aggregation: Underwater video system

→ Total number of medusae in the aggregation (inds)

Individual dry weight was estimated by following equation (Mean bell diameter (D: 23.8 cm) was usde)

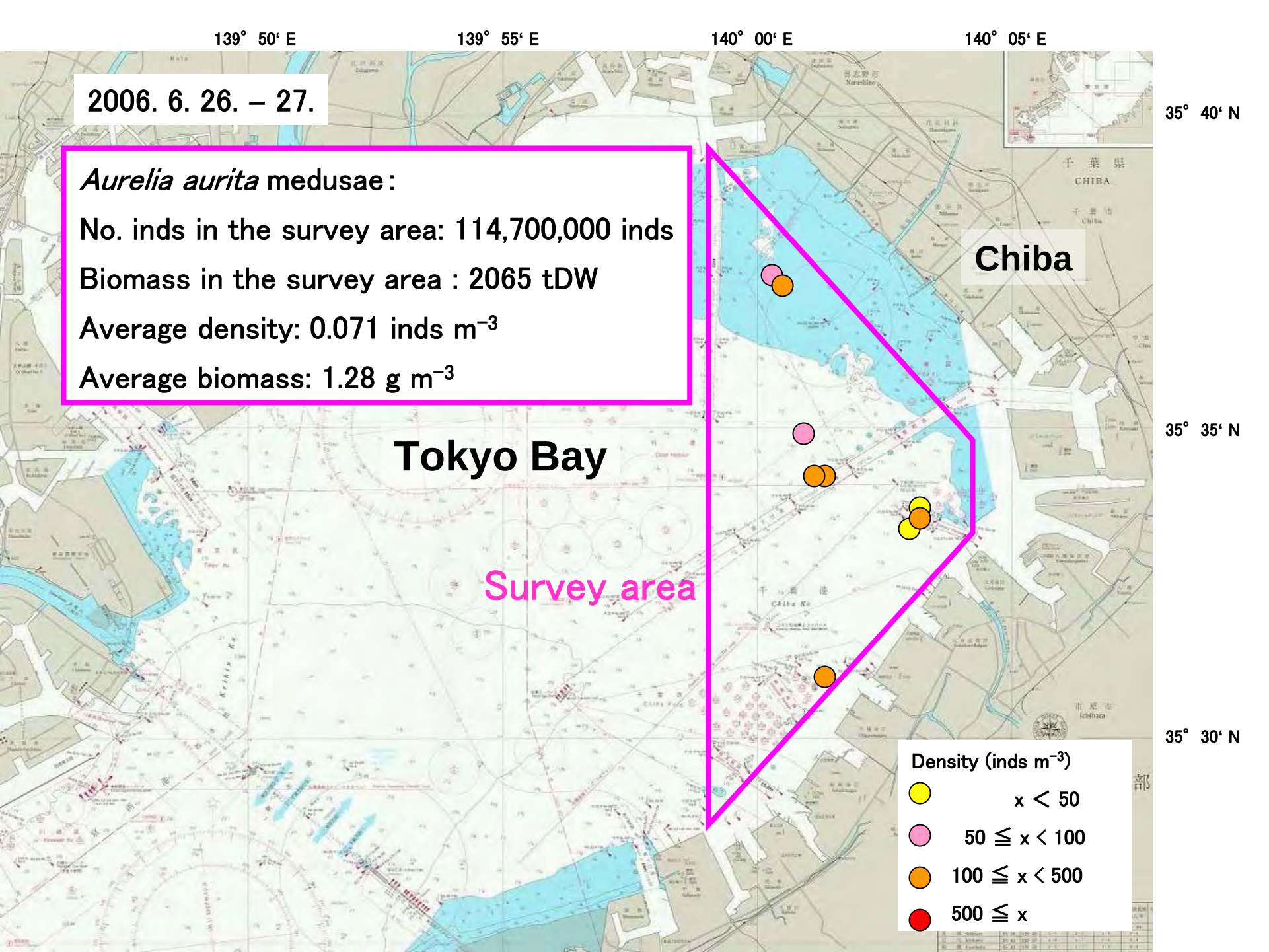
$$W = 0.0038 \times D^{2.67}$$ (Ishii & Tanaka 2006)

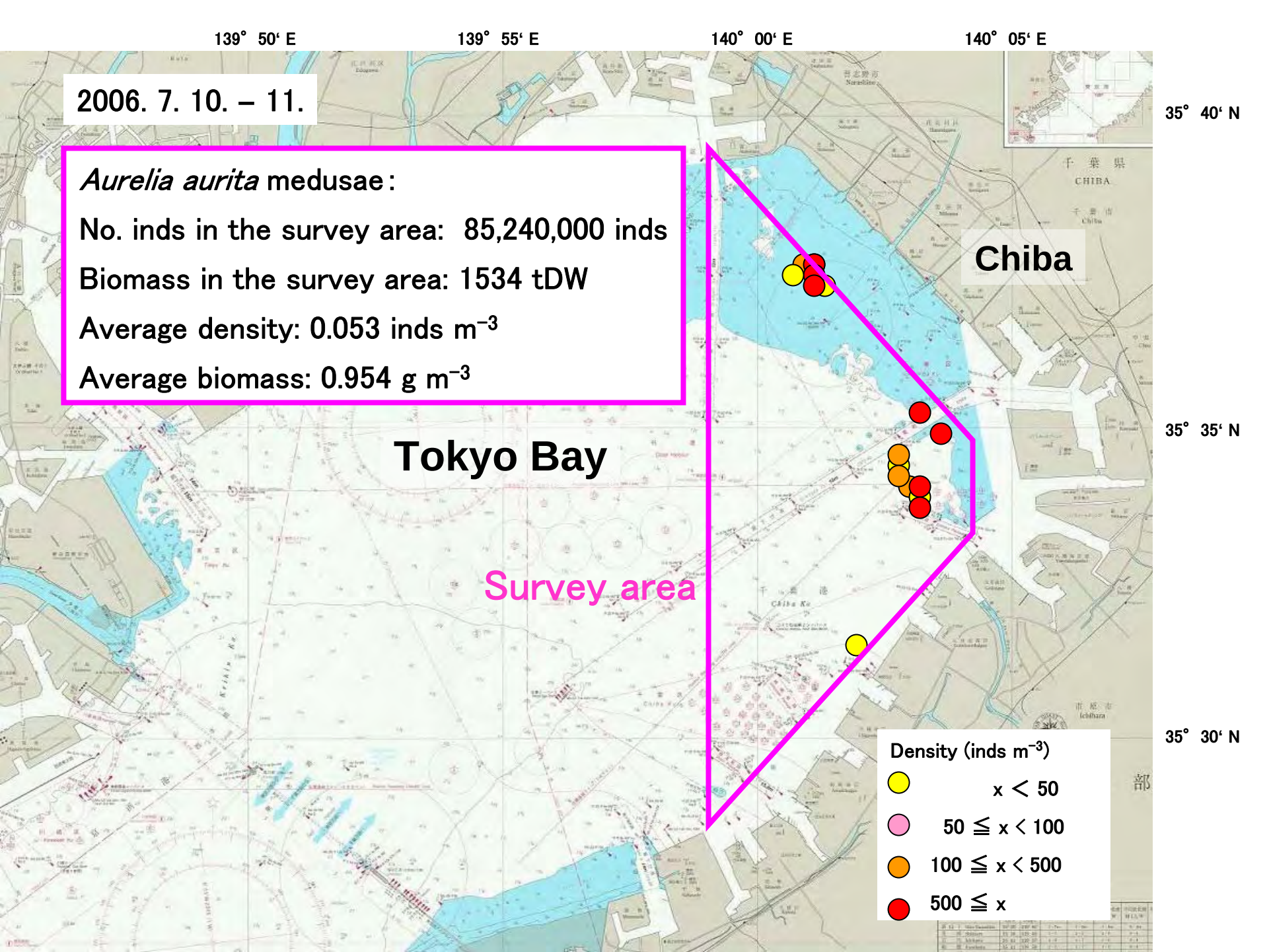
→ Total biomass of medusae in the aggregation (g)

Data of the survey area: Width; 107.2 km^2 Average depth; 15 m

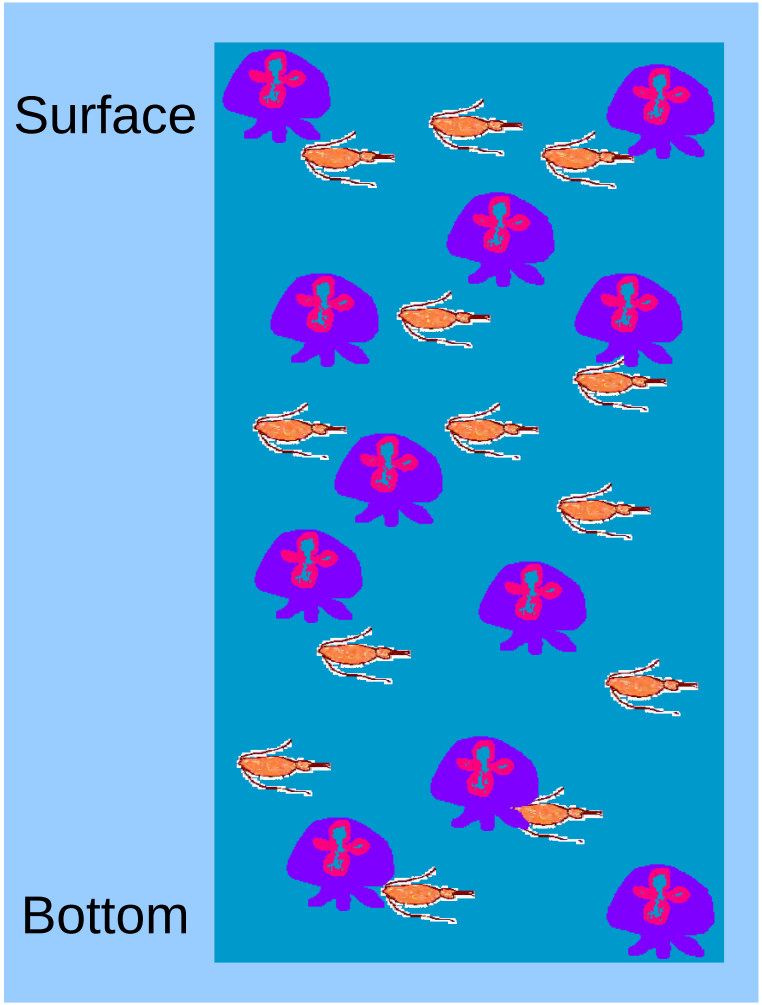
→ Average density in the survey area (inds m^{-3})

→ Average biomass in the survey area (g m^{-3})


139° 50' E
139° 55' E
140° 00' E
140° 05' E
35° 40' N
35° 35' N
35° 30' N
2006. 6. 26. – 27.
Aurelia aurita medusae :
No. inds in the survey area: 114,700,000 inds
Biomass in the survey area : 2065 tDW
Average density: 0.071 inds m^{-3}
Average biomass: 1.28 g m^{-3}
Tokyo Bay
Chiba
Survey area
Density (inds m^{-3})
x < 50
50 ≦ x < 100
100 ≦ x < 500
500 ≦ x


139° 50' E
139° 55' E
140° 00' E
140° 05' E
35° 40' N
35° 35' N
35° 30' N
2006. 7. 10. – 11.
Aurelia aurita medusae :
No. inds in the survey area: 85,240,000 inds
Biomass in the survey area: 1534 tDW
Average density: 0.053 inds m^{-3}
Average biomass: 0.954 g m^{-3}
Chiba
Tokyo Bay
Survey area
Density (inds m^{-3})
x < 50
50 ≦ x < 100
100 ≦ x < 500
500 ≦ x

Diel vertical migration of *A. aurita* medusae was not observed in Tokyo Bay



・Main prey of *A. aurita* medusae is cyclopoid copepod, *Oithona davisae* (Ishii & Tanaka 2001).

・Diel vertical migration is not also observed in *Oithona davisae*.

・It is no need to migrate, expending the energy, to feed the main prey for *A. aurita* medusae in Tokyo Bay.

・Is *O. davisae* population enough to sustain the *A. aurita* population as food?

Feeding impact of *A. aurita* medusae on the biomass and the production in the zooplankton community

Most dominant species of the zooplankton community in the innermost part of Tokyo Bay was *O. davisae*

Zooplankton biomass: 394 mgDW m^{-3} (191 mgC m^{-3})

Zooplankton production: 118 mgC m^{-3} d^{-1} Ikeda and Motoda (1978)

Maximum feeding rate of medusae in Tokyo Bay: 22 mgC $inds^{-1}$ d^{-1} Ishii and Tanaka (2001)

Average density of medusae: 0.071 (Jun) and 0.053 (Jul) inds m^{-3}

Feeding impact on zooplankton biomass: 0.82 (Jun) and 0.61(Jul) % d^{-1}

Feeding impact on zooplankton production: 1.3 (Jun) and 0.99 (Jul) % d^{-1}

Feeding impact of medusae on zooplankton community is negligible in the whole area in Tokyo Bay

Maximum density of medusae in the aggregation: 39 (Jun) and 89 (Jul) inds m^{-3}

Feeding impact on zooplankton biomass: 449 (Jun) and 1025 (Jul) % d^{-1}

Feeding impact on zooplankton production: 727 (Jun) and 1660 (Jul) % d^{-1}

Feeding impact of medusae on zooplankton community is very large within the aggregations, and most of zooplankton will be consumed by medusae as food. Medusae aggregations have to migrate horizontally or vertically to get enough foods.

Conclusion

For *A. aurita* medusae in Tokyo Bay

・In the most of aggregations, medusae were equally distributed in the water column between surface and bottom layer

・Maximum density of medusae with underwater video system was 89 inds m^{-3} (11 July)

・Apparent diel vertical migrations were not observed

・Medusae were distributed in the hypoxic layer, however, they were not observed in the anoxic zone near the bottom

・Significant difference in the bell diameter of medusae among the depths was not observed

・Average density of medusae in the innermost part of Tokyo Bay was 0.053 – 0.071 inds m^{-3}

・Average biomass of medusae in the innermost part of Tokyo Bay was 0.95 – 1.28 g m^{-3}

・Feeding impact of medusae on zooplankton community was negligible in the whole area in Tokyo Bay, however, within the aggregations, it was very large and most of zooplankton will be consumed by medusae as food. So aggregations of medusae have to migrate horizontally or vertically to get enough foods.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