Distribution and ecological aspects of the Siphonophora in the middle of South China Sea

LIN, M.

This paper reports species composition, horizontal distribution and seasonal variation of total individual and dominant species of the Siphonophora and their relationship to the environmental factors. Materials from the water layers within 0～200 m were collected during the periods of September, 1983, April and May, July and August, and December, 1984 in the study region (12°- 19°30′N, 111°- 118°E, Fig. 1).

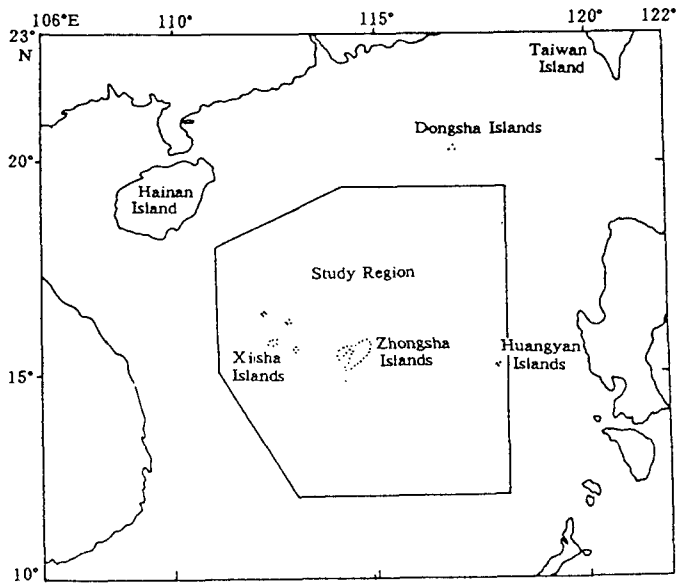

Fig. 1. A sketch map of the study region.

MATERIALS AND METHODS

There were 42 sampling stations in the study region. Altogether 166 quantitative zooplanktonic samples were obtained with a planktonic net (cone-shaped, 270 cm in length, 80 cm in mouth diameter, silk of JP12-15 meshes/cm) hauling vertically from the water layers at 200 m to the surface at a speed of 0. 5 m/s. The degree of biomass is expressed by number of individual with 0. 01 ind. /m water filtered.

RESULTS

Species composition and seasonal variation

In the study region, all species of the Siphonophora were identified, of which 58 species appeared in summer, 57 species in spring, 54 species in fall and 52 species in winter (Table 1).

Table 1. Species list and their seasonal distribution in the study region

Species	Spring	Summer	Fall	Winter
Agalma okeni	—	—	—	—
A. elegans	—	—	—	—
Nanomia bijuga	—	—	—	—
Halistemma rubrum	—	—	—	—
Physophora hydrostatica	—		—	
Athorybia rosacea	—		—	
Melophyes melo	—			
Nectalia loligo	—	—	—	
Forskalia edwardsi	—			—
Amphicaryon acaule		—		—
A. peltifera	—	—	—	—
A. ernesti	—	—	—	—
Rosacea plicata	—	—	—	—
Praya dubia	—			
Hippopodius hippopus	—	—	—	—
Vogtia spinosa		—		
V. pentacantha	—	—		
V. glabra	—	—	—	—
V. microsticella	—	—	—	
Sulculcolaria monoica	—	—	—	—
S. quadrivalvis	—	—	—	
S. turgida	—	—	—	—
S. biloba		—	—	—
S. chuni	—	—	—	—
S. angusta	—	—	—	—
S. bigelowi	—		—	—
Sulculcolaria sp.	—	—	—	—
Diphyes chamissonis	—	—	—	—
D. bojani	—	—	—	—
D. dispar	—	—	—	—
Lensia subtilis	—	—	—	—
L. subtiloides	—	—	—	—
L. leloupi			—	
L. campanella	—	—	—	—
L. meteori	—	—	—	—
L. reticulata			—	
L. fowleri	—	—	—	—
L. challengeri	—	—	—	—
L. hotspur	—	—	—	—

(To be continued on the next page)

(*Continued*)

Species	Spring	Summer	Fall	Winter
L. cossack	—	—	—	—
L. conoidea	—	—	—	—
L. multicristata	—	—	—	
L. grimaldi	—	—		
L. canopusi	—			
L. tottoni	—			
L. telouveleau	—	—	—	—
Lensia sp.	—	—	—	—
Muggiaea atlantica	—			
M. kochii		—		
M. delsmani		—		
Dimophyes arctica	—	—	—	—
Chelophyes contorta	—	—	—	—
Ch. appendiculata	—	—	—	—
Eudoxoides mitra	—	—	—	—
Eud. spiralis	—	—	—	—
Eudoxia macra	—	—	—	—
Sphaeronectes gracilis	—	—	—	—
Ceratocymba leuckarti	—	—	—	—
C. sagittata		—	—	—
C. dentata		—		—
Abyla trigona		—	—	—
A. haeckeli		—	—	
A. bicarinata	—	—	—	—
A. schmidti	—	—		—
A. ingeborgae			—	
A. peruana			—	—
Abylopsis tetragona	—	—	—	—
Aby. eschscholtzi	—	—	—	—
Bassia bassensis	—	—	—	—
Enneagonum hyalinum	—	—	—	—
Enn. scarsae	—	—		

Seasonal variation and horizontal distribution of total number of individual

The higher annual total number of individual appeared in summer, with a maximal mean value of 2. 16 ind. /m^3, the concentrative range more than a value of 5 ind. /m^3 and a maximal value of 9. 25 ind. /m^3 were found in waters to the south of Zhongsha Islands. A mean value of 1. 74 ind. /m^3 appeared in spring, with a concentrative range more than a value of 5 ind. /m^3 and a maximal value of 6. 44 ind. /m^3 in waters to the southeast of Hainan Island. A mean value of 1. 57 ind. /m^3 appeared in fall, with a concentrative range more than a value of 5 ind. /m^3 and a maximal value of 8. 78 ind. /m^3 in waters to the southwest of Zhongsha Islands. A mean value of 1. 24 ind. /m^3 appeared in winter, with a concentrative range more than a value of 2. 5 ind. /m^3 and a maximal value of 3. 52 ind. /m^3 in waters to the south of Dongsha Islands.

Distribution of dominant species

Chelophyes appendiculata (Eschscholtz). *Chelophyes appendiculata* is an oceanic eurytopic species. A mean value of 0. 29 ind. /m^3 appeared in spring, with more number of individual around the edge of the region. A mean value of 0. 3 ind. /m^3 appeared in fall, with a concentrative range more than 0. 5 ind. /m^3 and a maximal value of 1. 77 ind. /m^3 in waters to the southwest of Zhongsha Islands. A mean value of 0. 21 ind. /m^3 appeared in summer, with a concentrative range more than 0. 5 ind. /m^3 in the following waters: to the southeast of Hainan Island, with a maximal value of 0. 63 ind. /m^3; to the south of Dongsha Islands, with a maximal value of 0. 85 ind. /m^3; around Huangyan Island, with a maximal value of 1. 63 ind. /m^3. A mean value of 0. 08 ind. /m^3 appeared in winter, with a higher value in waters to the west of Zhongsha Islands and in the north of the study region.

Chelophyes contorta (Len & van Riemsdijk). *Chelophyes contorta* is an oceanic eurytopic species. A mean value of 0. 31 ind. /m^3 appeared in summer, with a concentrative range more than 0. 5 ind. /m^3 mainly in waters to the southeast of Xisha Islands and to the south of Dongsha Islands and a maximal value of 1. 25 ind. /m^3 for the former and 1. 39 ind. /m^3 for the latter. A mean value of 0. 32 ind. /m^3 appeared in fall, with a concentrative range more than 1 ind. /m^3 and a maximal value of 3. 84 ind. /m^3 in waters to the southwest of Zhongsha Islands. A mean value of 0. 16 ind. /m^3 appeared in spring and 0. 08 ind. /m^3 in winter.

Table 2. Seasonal variation of number of individuals of dominant species of the Siphonophora in the study region (0. 01 ind. /m^3)

Species	Spring	Summer	Fall	Winter	Annual mean value	Percentage of annual mean value of the Siphonophora
Chelophyes contorta	16	31	32	8	22	19%
Ch. appendiculata	29	21	30	8	22	19%
Bassia bassensis	19	34	11	10	19	17%
Eudoxoides mitra	13	15	10	19	14	12%
Abylopsis tetragona	12	15	12	15	14	12%
Aby. eschscholtzi	6	23	7	10	12	11%
Eudoxoides spiralis	10	8	5	16	10	9%

Bassia bassensis (Quoy & Gaimard). *Bassia bassensis* is an oceanic eurytopic species. A mean value of 0. 34 ind. /m^3 appeared in summer, with a concentrative range more than 0. 5 ind. /m^3 and a maximal value of 1. 76 ind. /m^3 in waters to the south of Zhongsha Islands. A mean value of 0. 19 ind. /m^3 appeared in spring, with a concentrative range more than 0. 25 ind. /m^3 mainly in waters to the south of Dongsha Islands with a maximal value of 0. 44 ind. /m^3 and to the south of Zhongsha Islands with a maximal value of 0. 43 ind. /m^3. A mean value of 0. 11 ind. /m^3 appeared in fall and 0. 10 ind. /m^3 in winter.

In addition to 3 dominant species mentioned above, other dominant species included *Eudoxoides*

mitra, *Eud. spiralis*, *Abylopsis tetragona* and *Aby. eschscholtzi* (Table 2) and common species, *Sulculeolaria chuni*, *S. quadrivalvis*, *Diphyes bojani*, *D. dispar*, *Lensia campanella*, *L. subtilis*, *L. hotspur* and *Ceratocymba leuckarti*.

Relationship between the distribution of the Siphonophora and environmental factors

The Siphonophora living in the water layers from 200 m to 0 m in the study region might be divided into the following ecological groups:

Neritic eurytopic group. This group consists of *Muggiaea atlantica*, *Diphyes chamissonis* and *Lensia subtiloides*.

Muggiaea atlantica dominates in the Siphonophora in spring in the north of the South China Sea. In China it is only found around waters between Hainan Island and Xisha Islands and the waters to its north. In this study, *M. atlantica* appeared in spring and was only found around waters between Hainan Island and Xisha Islands in the study region, with a centre of concentration of 5. 79 ind. / m^3 in waters to the southeast of Hainan Island, accounting for 89% of the value of the Siphonophora in the waters. This indicates strong neritic influence from Hainan Island.

In summer as the southwest monsoon was dominant, neritic water from the Java Sea as well as the Sunda Shelf came into the study region from the southwest. At this time, *D. chamissonis* and *L. subtiloides* decreased in amount as the salinity increased from southwest to the northeast. This corresponds to the week influence of neritic water gradully from southwest to the northeast in the study region.

In spring and fall, the monsoons change. The distribution of *D, chamissonis* and *L. subtiloides* was similar to that in summer except that they were relatively less amount. This indicates that the neritic water from the Java Sea as well as the Sunda Shelf still exercises influence on the study region except that their intensity has reduced relatively.

In winter, the northeast monsoon blows in the study region. The distribution of *D. chamissonis* and *L. subtiloides* was opposite to that in spring, summer and fall. They occurred mainly in waters in the north of the study region besides sporadic occurrence in waters nearby the Phillipines in the southeast of the study region. These may reflect that in winter neritic water from Guangdong, China and the Phillipines invade the study region as the northeast monsoon blows.

Oceanic eurytopic group. This group consists mainly of *Ch. appendiculata*, *Ch. contorta*, *B. bassensis*, *Aby. tetragona*, *Aby. eschscholtzi*, *Eud. mitra*, *Eud. spiralis*, *S. chuni*, *S. quadrivalvis*, *D. bojani*, *D. dispar*, *L. subtilis*, *L. hotspur* and *L. cossack*.

Oceanic stenotopic group. This group consists mainly of *Ceratocymba sagittata*, *C. leuckarti*, *Sulculeolaria tropica*, *S. angusta*, *Abyla haeckeli*, *A. bicarinata*, *A. schmidti*, *A. trigona*, *Vogtia spinosa*. They spread widely in the study region.

Oceanic deep-water group *Dimophyes arctica* is the representative of this group. It lives in the waters of lower temperature, as main species for the Siphonophora in Arctic and anarctic waters, and in deep water layers in oceanic warm-water region. It appeared for four seasons in hypopelagic-water up-

welling area in the west of the study region. In winter and spring, *D. arctica* appeared commonly in the south of the study region as hypopelagic water upwelled and disappeared in the northeast of the study region where it had appeared in summer and fall as relatively higher-temperature hypopelagic water from northwest Pacific invaded. These reflect that the distribution of *D. arctica* is under the influence of the movement and seasonal variation of hypopelagic water.

CONCLUSIONS AND DISCUSSIONS

In this paper, all 71 species of the Siphonophora are identified, dominant species including *Ch. appendiculata*, *Ch. contorta*, *Eud. Mitra*, *Eud. spiralis*, *Aby. eschscholtzi*, *Aby. tetragon* and *B. bassensis*; common species for *S. chuni*, *S. quadrivalvis*, *D. bojani*, *D. dispar*, *L. campanella*, *L. subtilis*, *L. hotspur* and *C. leuckarti*.

On the basis of the distribution of the neritic eurytopic group, it is concluded that neritic water from the Java Sea as well as the Sunda Shelf, Guangdong, the Phillipines exercises influence on the study region. Among these neritic-water masses mentioned above, it is evident relatively that the former has more distinct influence on the study region.

The distribution of *D. arctica* may reflect the movement and seasonal variation of hypopelagic water in the study region. The species occurs commonly in the waters with upwelling and upward hypopelagic water. In winter and spring, *D. arctica* dose not occur in the waters with hypopelagic water from the northwest Pacific. This reflects that the temperature of hypopelagic water from the northwest Pacific is higher than that in the study region.

Lin Mao

Third Institute of Oceanography, State Oceanic Administration, Xiamen, China

Received August 15, 1992.

Accepted September 15, 1992.