

# Benthic foraminifera of the genus *Ammonia* from the intertidal sandy/silty bottom of Sishili Bay, Yellow Sea

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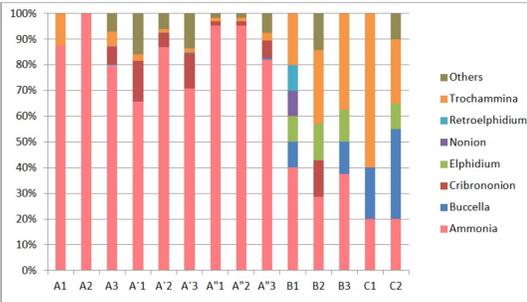
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## INTRODUCTION

One of the most abundant and widely distributed species among modern foraminifera is *Ammonia beccarii* (Cushman, 1931). Its range covers shallow waters of the southern and northern seas, the Atlantic and Pacific coasts, and coastal areas of ocean islands. Due to such cosmopolitanism and an extremely high degree of variability of forms, many experts worldwide express doubts that these forms belong to a single species, *Ammonia beccarii*. Identification of its various morphotypes has been the subject of serious debates over the past 50 years.

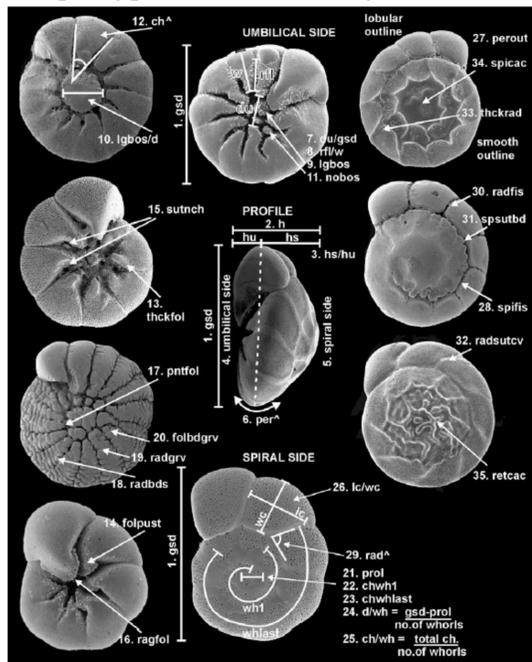
## RESULTS



**Fig. 2. The frequency of the benthic foraminifera in the studied area by genera.** Species of the genus *Ammonia* constitute the major part of the foraminifera fauna on the intertidal silty/sandy bottom of Sishili Bay (from 70 to more than 90% of the total foraminifera assemblage).

## Morphometric analysis

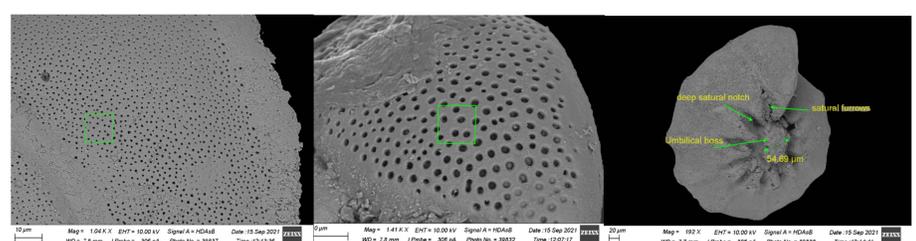
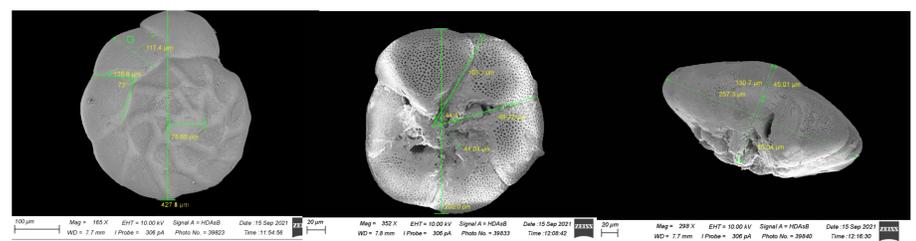
Recent studies by B. W. Hayward, M. Holzmann, J. Pawlowski and other leading researchers have contributed to establishing the significant morphological criteria that will help us identify the *Ammonia* morphotypes from Sishili Bay.



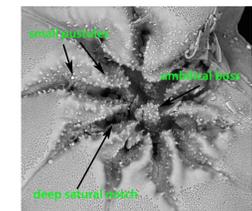
**Fig. 2. Characters used in morphometric analysis of *Ammonia* specimens in our study according to Hayward et al., 2021.**

There are 42 test characters measured or assessed on complete specimens and used in morphometric analysis (umbilical, spiral, profile view and the pore size measurements). 20 of them quantitative, 22 - qualitative characteristics. Scanning electron microscope (SEM) images of *Ammonia* specimens were measured. Only specimens with > 1,8 whorls were included.

Morphological studies using a scanning electron microscope were carried out at the Department of Electron Microscopy of NSCMB FEB RAS

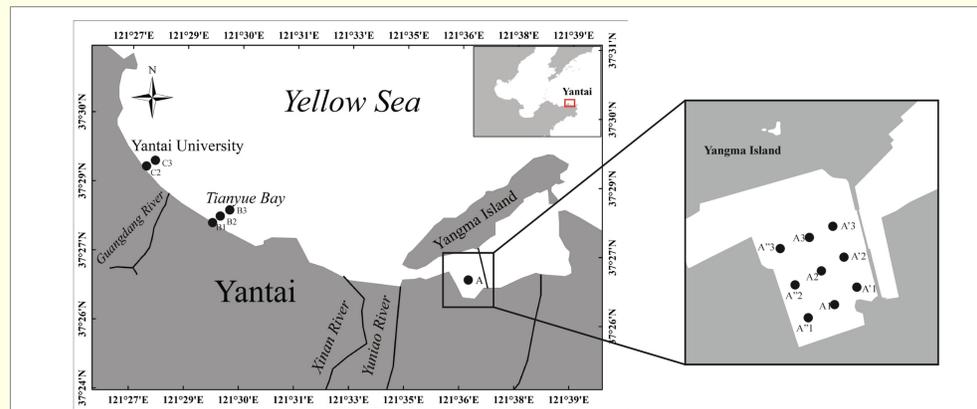


Pore characteristics as an additional criterion for identifying morphotypes



Umbilical quantitative assessments

The umbilical side is characterized by 5 important features: secondary lamination on folia, the presence of pustules, sutural notch, boss and tubercles



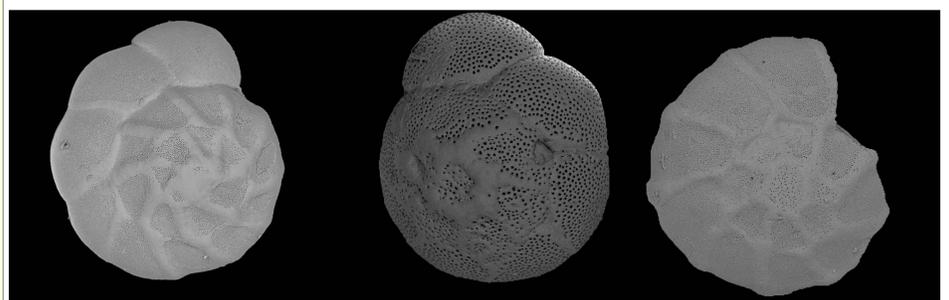
**Fig. 1. Schematic map of the study area and the locations of sampling stations in the Sishili Bay, Yellow Sea.**

	specimens	gsd	du/d	rfl/w	maxbos	lgbos/d	nobos	ch	prol	chwhl	chwhlast	d/wh	ch/wh	lc/wc	perout	rad^a
1	A Am-01	427,8	12,4	1,4	36,0	0	1	38,3	78,6	8	9,5	116,4	7,7	1,2	0,6	73,0
2	A Am-02	232,3	4,6	1,5	-	0	0	44,0	34,1	5	7,0	99,1	6,5	1,6	0,6	93,7
3	A Am-03	328,0	4,7	2,3	66,0	0	1	27,0	49,4	7	9,0	139,3	8,0	0,7	1,0	89,0

**Table. Values for the characteristics of foraminifera tests that were available for measurement for 3 distinguished morphotypes.** Values measured from SEM images. Gsd=greatest spiral diameter, du/d=relative diameter of umbilicus, rfl/w=relative length of radial sutural furrows, maxbos=diameter of largest umbilical boss, lgbos/d=relative size of single large umbilical boss, nobos = number of umbilical bosses, ch^a=chamber angle of chamber(n-1), prol=proloculus largest diameter, chwhl= number of chambers in first whorl, chwhlast= number of chambers in last whorl, d/wh=mean diameter of each whorl, ch/wh= mean number of chambers per whorl, lc/wc= relative chamber(n-1) proportions, perout=proportion of 360° peripheral outline that is smooth, not lobular, rad^a=angle between radial(n-1:n-2) and spiral sutures

## CONCLUSIONS

We have obtained primary results. We identified three morphotypes of the genus *Ammonia* and carried out all the necessary morphometric measurements and assessments. All three morphotypes differ in qualitative and quantitative characteristics. Based on the data of Hayward et al, 2021, we can assume that the A Am-01 morphotype corresponds to *A. confertitesta*, A Am-02 to *A. veneta*, and the third morphotype cannot be attributed to any of the identified by Hayward et al, 2021 and Lei, Li, 2016. We called it *A. sp.*



*A. confertitesta*

*A. veneta*

*A. sp*



**Fig. Umbilical and spiral side view of *Ammonia* species morphogroup, A stations, Sishili Bay, Yellow Sea.** 1-8, 13,14 - *A. confertitesta*, 9-12 - *A. sp.*, 15-16 - *A. veneta*. Photographs on a stereo microscope do not capture all the features of tests that are visible on a scanning microscope but prolonged observation of tests forms the skill of distinguishing more subtle characteristics that were not previously noticed.

Photographs were taken under the microscope Stereo Discover V.12. in Federal Scientific Center of the East Asia Terrestrial Biodiversity FEBRAS.