Front. Biol. China (2006) 2:213–218
DOI 10.1007/s 11515-006-0014-y

RESEARCH ARTICLE

Bai Zhiqiang, Xia Zunyi

Recent approach to *Buchia* biostratigraphy from the Tethyan Himalaya area, China

Abstract Recent collections from six sections in Lanongla area, Tethyan Himalaya allow the establishment of four *buchia* assemblages. In ascending order, they are *Buchia-Buchia spitiensis, Buchia masquensis-Buchia rugasa, Buchia blanfordiana, Buchia piochii and Buchia subokensis assemblages*. These *Buchia* assemblages first demonstrate that not only the Upper Jurassic strata but also the highest *Buchia assemblage-Buchia subokensis,* which appeared in Lower Cretaceous strata all over the world are present in Lanongla area. This first records the highest *Buchia* assemblage in Lanongla area.

Keywords: *Buchia*, Upper Jurassic, Lower Cretaceous, Tethyan Himalaya area

1 Introduction

The highest Upper Jurassic-lower Cretaceous *Buchia* assemblage in Tethyan Himalaya area, by Gou Zonghai (Gou 1983, 1984, 1990, 1993, 1994, 1997), is *Buchia piochii-Buchia gucuoensis* (occurring in upper part of Xiumo fm.). Lower Cretaceous *Buchia* haven't been observed in Himalaya area so far from research reports. By Sha Jingeng (Sha and Yuan 1985; Sha 1991 1992)，in western Dongan town of Raohe County, Heilongjiang Province, China (Chen and Huang 1992), the highest *Buchia* assemblage is *Buchia fischeriana*, an assemblage of Upper Jurassic. In Nyalam-Guco area, recent collections from six sections (Lanongla, Guco, Buchiola, Pure, Sanniugou and Zandun), Tethyan Himalaya area, Tibet Autonomous Region, China, measured by Pro. Yin Jiarun (China University of Geoscience) and Bureau of Geology and Mineral Resources of Tibet Autonomous Region in 1999, show that besides the former identified Late Jurassic *Buchia*, the Early Cretaceous Buchiola of *Buchia subokensis* are identified in Sanniugou section. In the Lanongla section occur especially abundant *Buchia*. Roughly 100 *Buchia* fossils are collected from the six sections and are divided into 18 species including 3 undefined species. Four *Buchia* assemblages can be identified in the six sections (*Buchia concentrica-Buchia spitiensis*, *Buchia mosquensis-Buchia rugosa*, *Buchia blanfordiana-Buchia piochii* and *Buchia subokensis*). This is the first report of the highest *Buchia* assemblages in this area.

Buchia is a sort of cosmopolitan bivalve, existing from Late Jurassic to Early Cretaceous. Contrasted with ammonites' unitary genera and species in *Buchia* time, *Buchia* has shorter life period, expeditious evolvement and peculiar shape. Therefore, they are frequently employed in stratigraphic classification and correlation in most contemporaneous strata.

Translated from *Acta Scientiarum Naturalium Universitatis Pekinensis*, 2005, 41 (4) [译自：北京大学学报(自然科学版)，2005,41(4)]

Xia Zunyi, Bai Zhiqiang (✉)
Department of Geology, Peking University, Beijing 100871, China
E-mail: zqbai@pku.edu.cn

2 Strata occurring *Buchia*

Lanongla is a key Jurassic-Cretaceous section in China. Gamba, Nyalam and Gyirong are dominated by siliciclastics with wavy thickness. The thickest in Northern Nyalam is 820 m and is decreasing to the east or west (Burang and Zanda 230 m). Through measurement and identification, roughly 100 sample *Buchia* fossils have been found including 15 known species and 3 undefined species. *Buchia* biostratigraphic section is as follows:

2.1 Menkadun Fm. (J_{3m})

Bed 6 Gray black-gray yellow thin-bedded mudstones, siltstones, and shales. Roughly 25 m black shales thin-bedded silty mudstones and shales at the top. Roughly 30 m gray green, subfuscous thin-bedded mudstones and silty shales with iron concretions are located at medium part. Black shales dominate downwards and individual part occurring abundant bivalves

fossils of *Buchia*, roughly 70 m thickness.

Bed 5 Black-black gray shales, thin-bedded mudstones with gray green thin bedded silty mudstones, with abundant iron, calcium and mud concretions and occurring *Uhligites* sp., roughly 90 m thickness.

Bed 4 Gray green-gray brown thin-bedded silty mudstones, muddy silts and shales, with iron, calcium concretions. 30 m of top occur abundant bivalves *Buchia*; *Buchia spitiensis, Buchia concentrica, Buchia extensa, Buchia megarostrata, Buchia blanfordiana, Buchia cardioca, Buchia fischerana, Buchia piochii, Buchia shuomoensis, Buchia mosquensis.* Most shells are attacked and only kernels remained, roughly 80 m thickness.

Bed 3 Dark gray-black gray shales,thin-bedded mudstones, with silty and abundant iron and calcium concretions, occurring ammonites, roughly 80 m thickness.

2.2 Qumile Fm. (J_{2q})

Bed 2 Purple red ferruginous ooid sandstones, with extremely high ferrums, occurring ammonites, bivalves and brachiopoda, roughly 0.3~3 m thickness.

2.3 Nienielaxiong Fm. (J_{2n})

Bed 1 Dark gray-gray brown medium-thick bedded (40~70 m) bioclastic muddy limestones alternated with gray white-light gray thin bedded silty mudstones (20~60 m), occurring abundant brachiopoda *Rhynchonelloidella* and *Scalpellirhynchia,* roughly 25 m thickness.

(Annotate: the above mentioned *Buchia* fossils in Lanongla section depend on the study by Xv et al. (1990)., so there are no credible records of the exact occurring positions)

Guco section located 1 km southwest of Guco, Nyalam County, stretching to south along Ding ri-Nyalam Road, is 798 m long. This section includes Upper Jurassic-Early Cretaceous strata. The lithologic character description is from Pro. Gou Zonghai's field notes. The known species of *Buchia* is the result of sample identification of this study. Five beds to discover *Buchia* fossils are described as follows from lower to upper.

2.4 Menkadun Fm. (J_{3m})

Top unmeasured.

Bed 5 Gray green thin-bedded medium siltstones, with thin-bedded fine sandstones, individual observing bivalves *Trigonia* clastics. >200 m

Bed 4 Black shales with sillty shales, with abundant calc-muddy concretions, occur ammonites and bivalves *Buchia*.

Ammonites: Berriasella, Blanfordiceras, Kilianella.

Bivalves: Pleuromya uniformi, Nucula ef. menkii, Inoceramus ef. everesti. 45 m

Bed 3 Gray white thick-bedded massive medium-grained coarse quartz sandstones. 50 m

Bed 2 Gray, dark gray sandy shales, black shales, with abundant calc-muddy concretions, occurring ammonites, bivalves *Buchia* and Belemnites.

Ammonites: *Virgatosphinctes Pterolytoceras, Haplophy- lloceras*

Bivalves: *Astarte sp., Inoceramus ef. Everesti, Buchia megarostrata, Buchia sp., Buchia rugosa, Buchia mosquensis, Buchia volgensis, Buchia shuomoensis.* Approximately 70 m

Bed 1 Muddy limestones with thin-bedded limestones at the top, dark gray thin-bedded medium limestones and muddy limestones at the medium and lower parts.

Bottom not exposed.

Buchiola section exposes in a small channel, roughly 80m Western Lanongla section. Roughly 10 m thick yellow gray muddy shales are exposeed in this crop. Lower part dominated with ammonites and upper part with *Buchia*. *Buchia* have 2 beds. One overlies ammonites *Uhligites* sp. and the other underlies ammonites *aplophylloceras pinque.*

3 Stratigraphy meaning

Based on recent materials four *Buchia* assemblages can be identified as follows (from lower to upper):

3.1 *Buchia concentrica-Buchia spitiensis* (plate I, II[1])

There are four species. Besides the two species above-mentioned, there are *Buchia extensa, Buchia curtusa.* The 3rd fossil assemblage from Lanongla (L_3), the 6th fossil assemblage from Buchiola (B_6) and the 3rd fossil assemblage from Pure sections are characteristic of *Buchia concentrica* (Sowerby) and *Buchia spitiensis* (Holdhaus).

The dominated members of this assemblage, *Buchia concentrica* (Sowerby), *Buchia spitiensis* (Holdhaus), widely occur in Late Oxfordian to Kimmeridgian strata in China and others (Fig. 1), for instance, in Western Himalayan (Spiti region), west seacoast of the USA, Alaska, Northwestern Europe, *etc*. (Holdhaus 1913; Anderson 1945; Imlay 1955; Cox 1965; Surlyk and Zakharov 1982). Except *Buchia, ammonites* and individual Belemnites, no other sorts of fossils are observed in this assemblage.

3.2 Buchia mosquensis-Buchia rugosa assemblage

There are six species. Besides two species above-mentioned, there are *Buchia megarostrata, Buchia cardioca, Buchia curtusa, Buchia spitiensis, Buchia blanfordiana, Buchia concentrica.*

[1] Samples are preserved in Paleontology Staff Room of China University of Geoscience (Beijing). Photos are 75% size of original ones.

This assemblage occurs in medium part of Menkadun Fm.

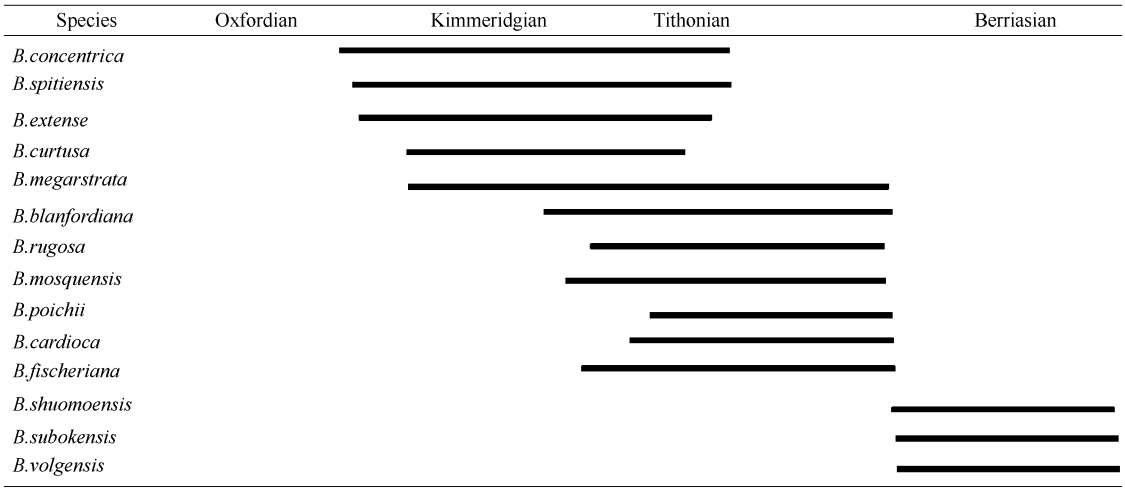


Fig. 1 Range chart of the Buchia species of the Nyalam area

Fossils are sampled from 5th fossil assemblage (S_5) of Sanniugou section, in characteristic of genera and species' high differentiation degree of *Buchia.* The dominated members, *Buchia megarostata, Buchia megarostata,* occur in Late Kimmeridgian or Early Tithonian strata in Alaska (Imlay 1959), the Arctic Ocean region of Canada, northeastern Columbia of Britain and Greenland (Jeletxky 1963,1965).

3.3 Buchia blanfordiana-Buchia piochii assemblage

There are four species. Besides two species above mentioned, there are *Buchia rugosa, Buchia piochii, Buchia megarostrata, Buchia blanfordiana, Buchia cardioca, Buchia spitiensis, Buchia blanfordiana, and Buchia concentrica.*

This assemblage occurs in top of Menkadun Fm. Fossils are sampled from 5th fossil assemblage (S_5) of Sanniugou, 1st fossil assemblage of Guco and Lanongla sections, in characteristic of abundant *Buchia blanfordiana* and *Buchia cardioca.*

Fossils are unitary. Except for the syngenetic ammonites, no other phylum is observed.

Buchia piochii, Buchia blanfordiana, Buchia fischiana occur in Late Tithonian strata in east Greenland (Surlyk and Zakharov 1982), northern temperate zone of Canada and northern California areas.

3.4 Buchia subokensis assemblage

There is one species. Fossils are sampled from 5th fossil assemblage (S_5) of Sanniugou section and occur in Early Cretaceous in East Greenland(Surlyk and Zakharov 1982), northern temperate zone of Canada and northern Alaska (Imlay 1955), Columbia of Britain and Northeastern Asia. The appearance of *Buchia subokensis* has been regarded as the beginning of Cretaceous worldwide. The first sampled *Buchia subokensis* fossils in Nyalam-Guco area (see plate I, 12) show that Cretaceous strata have been exposed in the position of 5th fossil assemblage (S_5) of Sanniugou section. This assemblage is that of Early Cretaceous too.

4 Ecological significance

Jurassic *Buchia*'s species, shape, size and occurring frequency depend on salinity, depth and temperature of seawater to some extent, and at the same time are influenced by the amount of oxygen in seawater and the attribute of sea floor. Those *Buchia*'s positions have accordant lithological character, such as fine siliciclastics, *i.e.* gray green siltstones, muddy siltstones *etc*. with abundant concretions, in which there exist ammonites fossils. This sort of lithological character suggests low-energy zone depositional environment. The symbiotic ammonites, in general, are regarded as living in bathymetric fascia depositional environment (Zhao 1976). By means of systematic analysis on *Buchia* in research region, we have such occurring characters as follows: 1) *Buchia*'s diverse genera and species, large biomass and rarely symbiotic other species of bivalves show that other species of bivalves could not accommodate *Buchia*'s living environment. 2) In the recent identified *Buchia subokensis and Buchia shuomoensis, Buchia subokensis* is a typical member of Early Cretaceous, and its appearance illustrates that there are Cretaceous strata exposed. 3) Involved in *Buchia*'s transferred hypothesis (Sha 2003). *Buchia subokensis* occurs in Early Cretaceous strata in North America and Canada (Imlay 1959; Jeletxky 1963). If the hypothesis of transfer from northern part areas

to southwest (Li and Grant-Mackie 1988) is correct, *Buchia subokensis'* occurring in southern Tibet would not be earlier than that in North America. The identification of *Buchia* in southern Tibet will facilitate Late Jurassic-Early Cretaceous stratigraphic correlation between northern part areas and southwestern Pacific Ocean areas and give new evidence for *Buchia*'s transfer.

Acknowledgements This study was supported by the National Natural Science Foundation of Chian (No. 40372018) and Docteral Fund (No. 20020001054)

References

Anderson F.-M., Knoxville Seris in the California Mesozoic, Geol. Soc. Amer. Bull., 1945, 56: 909–1014

Chen J.-H., Huang Guanjun. Upper Jurassic Buchiid (Bivalve) Sequence in Suibin area, Eastern Heilongjiang, NE China, Acta Palaeontol. Sinica, 1992, 31(2): 163–177 [陈金华，黄冠军. 黑龙江绥滨地区晚侏罗世 *Buchia* 带，古生物学报，1992, 31(2): 163–177]

Cox L.-R., Jurassic Bivalvia and Gastropoda from Tangenyika and Kenya, Bull. Brit. Mus. (Net. Hist.) Geol., 1965, Sup (1): 1–213

Gou Z.-H. and Li X.-C., Pilot Study on Jurassic *Buchia* Fauna in Nyalam Area, Tibet, Contribution to the Geology of the Qinghai-Tibet Plateau (11), Beijing: Geological Publishing House, 1983: 199–230 [苟宗海，李晓池, 西藏聂拉木地区侏罗纪双壳类动物群的初步研究, 青藏高原地质文集 (11), 北京：地质出版社，1983：199–230]

Gou Z.-H., Later Jurassic *Buchia* Fauna in Everest area, Southern Tibet, J. Chengdu Geol. Coll., 1984, 2: 21–23 (in Chinese) [苟宗海, 藏南珠峰地区晚侏罗世雏蛤动物群, 成都地质学院学报，1984，2: 21–23]

Gou Z.-H., Recent information of Bivalves fossils in southern Tibet, Tibet Geol., 1997, 1: 39–51 [苟宗海, 西藏南部地区双壳类化石新材料, 西藏地质，1997, (1): 39–51]

Gou Z.-H., Recent information of Jurassic-Cretaceous Bivalves Fossils in Zanda and Geer areas, Tibet, J. Chengdu Geol. Coll., 1993, 20(1): 34–40 [苟宗海, 西藏扎达、噶尔地区侏罗—白垩纪双壳类化石新材料, 成都地质学院学报，1993, 20 (1): 34–40]

Gou Z.-H., Some new Bivalves fossils of Cretaceous in medium areas of Tibet, J. Chengdu Geol. Coll., 1990, 17(1): 31–36 [苟宗海, 西藏中部白垩纪一些新的双壳类化石, 成都地质学院学报，1990，17 (1): 31–36]

Gou Z.-H., Study on Later Jurassic-Early Cretaceous *Buchia* fossils in Tibet, Tibet Geol., 1994, 2(Tot. No.12): 128–138 [苟宗海, 西藏晚侏罗世—早白垩世的雏蛤（*Buchia*）化石研究, 西藏地质，1994，2 (总 12): 128–138]

Holdhaus K., The Fauna of the Spiti Shales (Lamellibranchiata and Gastropoda), Palaeont Indica, 1913, 94 (2): 397–456

Imlay R.-W., Characteristic Jurassic Mollusks from Northern Alaska, Prof. Pap. US Geol. Surv., 1955, 374–D

Imlay R.-W., Succession and speciation of the Pelecypod Aucella, Washington, Shorter Contributions to General Geology, 1959, 314-G: 155–169

Jeletxky J.-A., Late Upper Jurassic and early lower cretaceous fossil zones of Canadian Western Cordillera, British Columbia, Bull. Geol. Surv. Canada, 1963, 103

Jeletxky J.-A., Late upper Jurassic and early lower cretaceous fossil zones of the Canadian Western Cordillera, British Columbia, Canada, Bull.- Geol. Surv. Can., 1965, 103: 1–70

Li X., Grant-Mackie J.-A., Upper Jurassic and Lower Cretaceous Buchia (Bivalvia) form Southern Tibet, and some wider consideration, Alcheringa, 1988, 12: 249–268

Sha J.-G., A different opinion on the geological ages of the Longzhaogou and Jixi groups of Eastern Heilongjiang, China, Acta Geol. Sin., 1991, 65(4): 376–383 [沙金庚, 对黑龙江东部龙爪沟群和鸡西群时代的不同认识, 地质学报，1991，65（4）：376–383]

Sha J.-G., *Buchia* and *Aucellina* genera, Eastern Heilongjiang, China, J. Stratigr., 1992, 16(1): 41–48 [沙金庚, 黑龙江省东部 *Buchia* 和 *Aucellina* 属, 地层学杂志，1992，16 (1): 41–48]

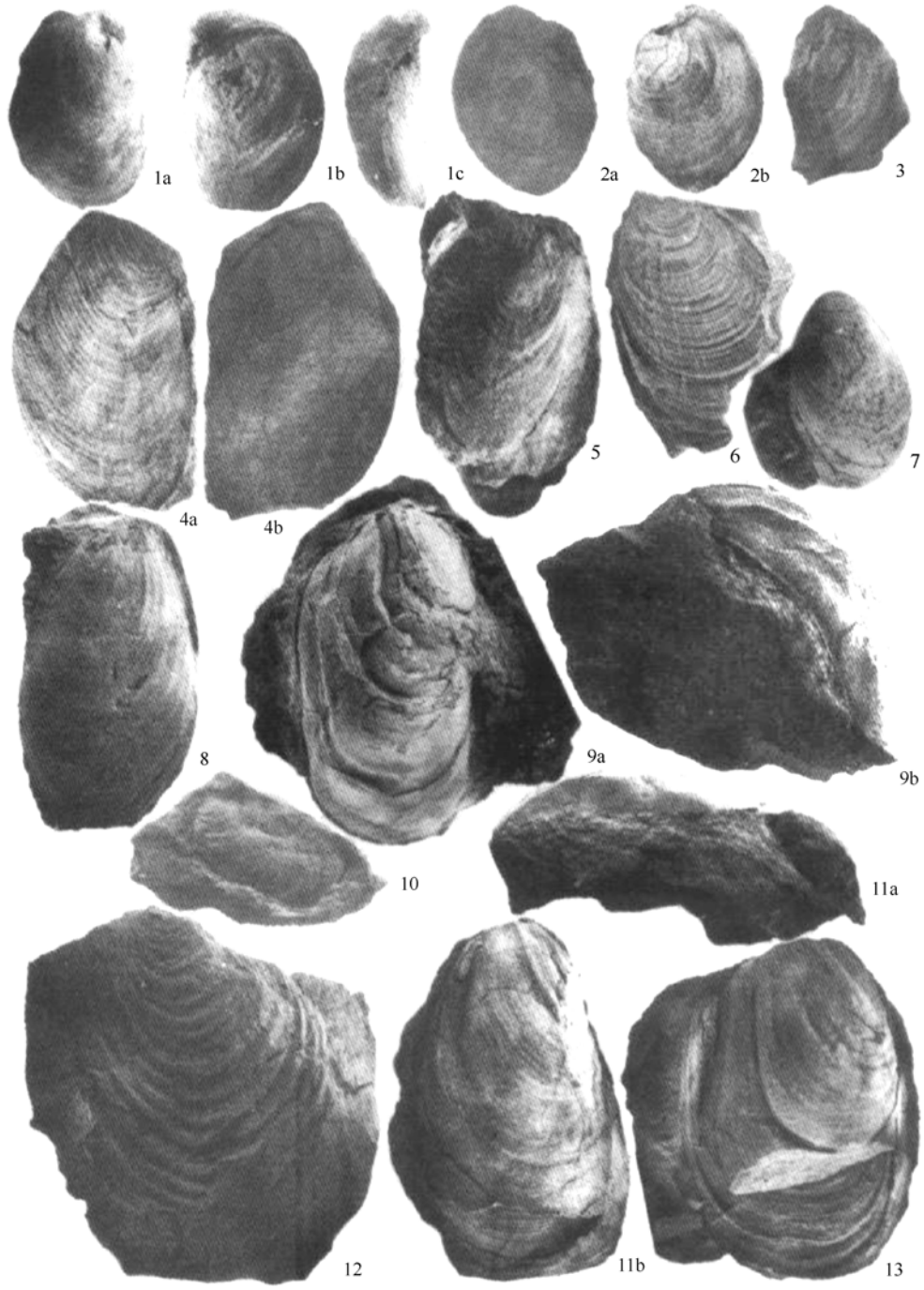
Sha J.-G., Plankton and pseudoplankton of the marine mesozoic bivalves, Acta Palaeontol. Sinica, 2003, 42(3): 408–416[沙金庚，中生代海相双壳类（软体动物）的漂浮与假漂浮, 古生物学报，2003, 42 (3): 408–416]

Sha J.-G., Yuan Fusheng. *Buchia* colony of Donganzhen Formation, Raohe, Heilongjiang, China, J. Chengdu Geol. Coll., 1985, 24(6): 651–662 [沙金庚，袁福盛, 黑龙江饶河东安镇组的 Buchia 化石群, 古生物学报，1985, 24 (6): 651–662]

Surlyk F. and Zakharov V.-A., Buchiid bivalves from the Upper Jurassic and Lower Cretaceous of East Greenland, Palaeontology, 1982, 25(4): 727–753

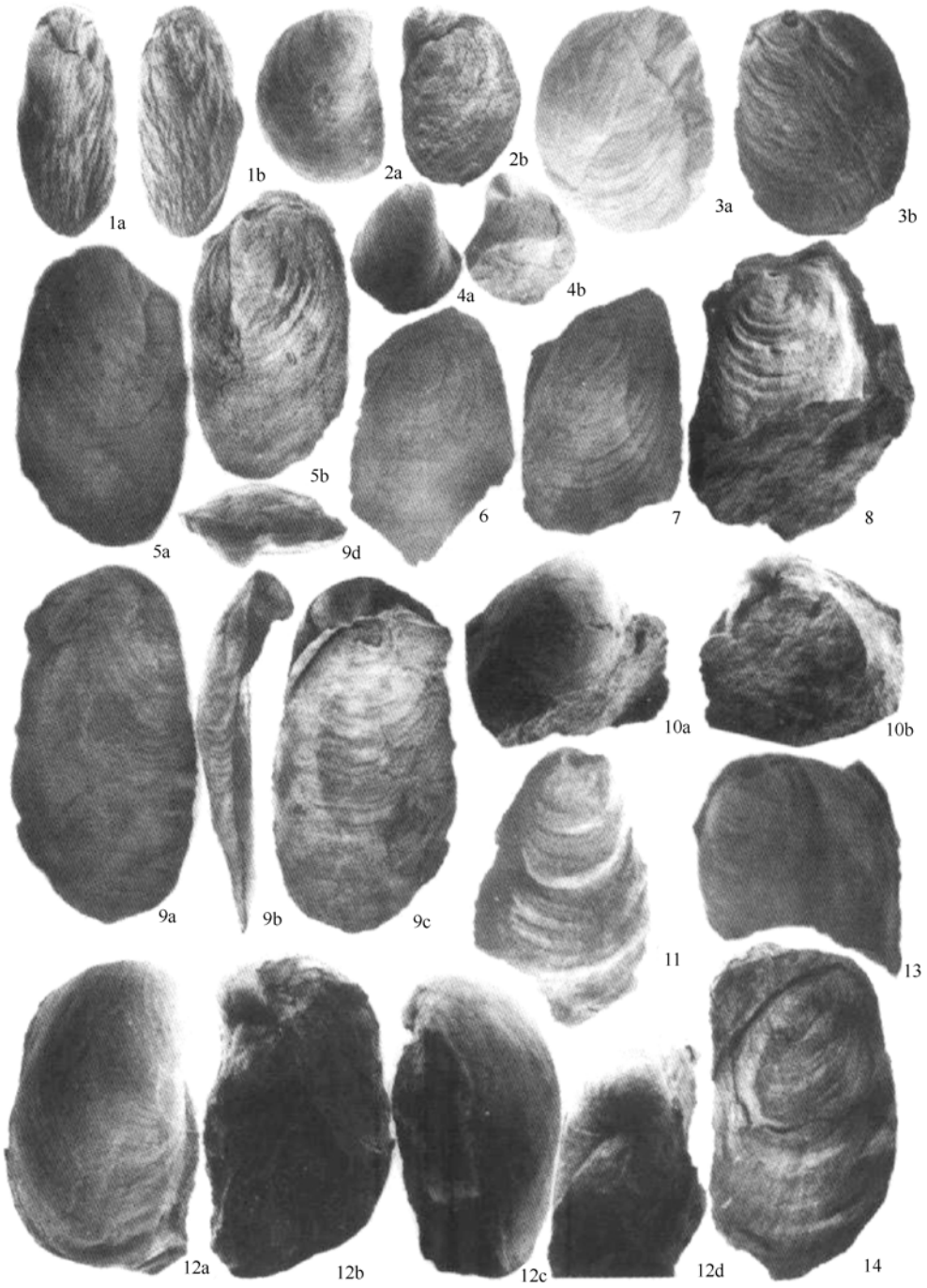
Xv Y.-L., Gou Z.-H. and Wan X.-Q., Jurassic, Cretaceous and Tertiary Strata in Tibet, Beijing: China University of Geosciences Press, 1990 [徐钰林，苟宗海，万晓樵, 西藏侏罗、白垩、第三纪地层. 北京：中国地质大学出版社，1990]

Zhao J.-K., Jurassic and Cretaceous Ammonites in Everest Area. Science Review Report of Everest Area (1966–1968), Palaeontology (3rd Fascicule), Beijing: Science Press, 1976 [赵金科, 珠穆朗玛峰地区侏罗，白垩纪菊石. 珠穆朗玛峰地区科学考察报告（1996–1968），古生物（第三分册），北京：科学出版社，1976]



1 *Buchia spitiensis* (Holdhaus) a. left lateral view b. right lateral view c. posterior view sample: zh1 Nyalam, southern Tibet, Pure section, Menkadun Fm.; 2 *Buchia fischeriana* (d' Orbigny) a. left lateral b. right lateral sample:L3 southern Tibet, Lanongla, Menkadun Fm.; 3 *Buchia spitiensis* (Holdhaus) right lateral, FG99ED11-1 Nyalam, southern Tibet, Zandun, Menkadun Fm.; 4 *Buchia blanfordiana* (Stoliczka) a. right lateral b. left lateral, L2 Nyalam, southern Tibet, Lanongla, Menkadun Fm.; 5 *Buchia blanfordiana* (Stoliczka) right lateral, 617-3-1 Nyalam, southern Tibet, Pure section, Menkadun Fm.; 6 *Buchia concentrica* (Sowerby) exterior mould of right, Z2 Nyalam southern Tibet, Buchiola section, Menkadun Fm.; 7 *Buchia volgensis* (Lahusen) left lateral, 3436 southern Tibet, Guco area, Guco, Guco Fm.; 8 *Buchia blanfordiana* (Stoliczka) right lateral, 617-3-1 Nyalam, southern Tibet, Pure, Menkadun Fm.; 9 *Buchia spitiensis* (Holdhaus) a. left lateral b. anterior c. posterior, L13 southern Tibet, Lanongla, Menkadun Fm.; 10 *Buchia spitiensis* (Holdhaus) left lateral, FG99ED11-1 Nyalam, southern Tibet, Zandun, Menkadun Fm.; 11 *Buchia spitiensis* (Holdhaus) a. posterior b. left lateral, L14 southern Tibet, Lanongla, Menkadun Fm.; 12 *Buchia subokensis* (Paylow, 1907) left lateral, 99SJF2-13 Nyalam, southern Tibet, Sanniugou, Guco Fm.; 13 *Buchia spitiensis* (Holdhaus) left lateral L15 southern Tibet, Lanongla, Menkadun Fm.

Plate I Buchia fossils of Guco-Lanongla area, Southern Tibet, China



1 *Buchia concentrica* (Sowerby) a-b. left-right lateral c-dorsal: zh1 Nyalam,, Pure, Menkadun Fm.; 2 *Buchia spitiensis* (Holdhaus) a-b. left-right lateral: zh2 Nyalam, Pure, Menkadun Fm.; 3 *Buchia concentrica* (Sowerby) a-b. left-right lateral: 99SJF2-5 Nyalam, Sanniugou, Menkadun Fm.; 4 *Buchia mosquensis* (Buch) a-b. left-right lateral: 99SJF2-11 Nyalam, Sanniugou, Menkadun Fm.; 5 *Buchia extensa* (Holdhaus) a-b. left-right lateral:L1-b, Lanongla, Menkadun Fm.; 6 *Buchia extensa* (Holdhaus) right lateral:L1-e, Lanongla, Menkadun Fm.; 7 *Buchia extensa* (Holdhaus) right lateral:L1-d, Lanongla, Menkadun Fm.; 8 *Buchia extensa* (Holdhaus) right:L9, Lanongla, Menkadun Fm.; 9 *Buchia extensa* (Holdhaus) a-d. right, lateral, posterior, left lateral, posterior:L1-a, Lanongla, Menkadun Fm.; 10 *Buchia blanfordiana* (Stoliczka) a-b. left-right lateral: 617-5-1 Nyalam, Pure, Menkadun Fm.; 11 *Buchia cardioca* (m.s.) right lateral: F1-2 Nyalam, Buchiola, Menkadun Fm.; 12 *Buchia blanfordiana* (Stoliczka) a-b. left-right lateral c-d. anterior-posterior: 617-5-1 Nyalam, Pure, Menkadun Fm.; 13 *Buchia cardioca* (m. s.) right lateral: L11, Lanongla, J_{3m}; 14 *Buchia spitiensis* (Holdhaus) right lateral: L15, Lanongla, J_{3m}.

Plate II *Buchia* fossils of Guco-Lanongla area, Southern Tibet, China