A Revision of the Genus Sanyuania Zhao and Han, 1980
Ostracoda, Crustacea) with the Description of New
Species from the Late Cainozoic of China

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ABSTRACT
The endemic genus Sanyuania, one of the most important elements of the Cainozoic brackish water faunas
unique to China, is redescribed, and 3 new species, S. wangi, S. cuneata and S. sublaevis are established,
based on Quaternary material from the eastern coast of China. The evolution of the genus is discussed and
a general trend involving a reduction in the strength of carapace ornamentation with time is established,
as is a general migration seawards exhibited by subsequent chronological species. J. Micropalaeontol., 11 (2):
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INTRODUCTION
Sanyuania was first recorded in manuscript by Huang in
1970's from the Pliocene and early Pleistocene of the Fenwei
Basin of Shanxi Province, central China. It has subsequently
proved to be widespread in Quaternary sediments of eastern
China, along the coasts of the Yellow and East China Seas
(Zhao and Han, 1980; Zhao et al., 1986; Hou et al., 1982; Wang,
1982; Zhang, 1985; Yang et al., 1988; and others). The signifi-
cance of this genus in the paleoenvironmental analysis of
these sediments has been briefly mentioned by one of us (Zhao
and Han, 1980; Zhao et al., 1986) and its appearance in Quater-
nary sediments of coastal areas is considered as a reliable
indicator of marine-continental transitional facies. Sanyuania
was once thought to be monotypic. Additional material,
however, have been collected in recent years during our
studies of the late Cainozoic and Recent Ostracoda of eastern
China. The purpose of this paper is to describe these new
species of Sanyuania and to emend its diagnosis, and also to
comment on its significance as one of the most important
elements of late Cainozoic brackish water faunas of China.

All type and figured specimens described herein are housed
in the Department of Palaeontology, British Museum of Natu-
ral History.

SYSTEMATIC DESCRIPTIONS
Order Podocopida Sars, 1866
Suborder Podocopina Sars, 1866
Superfamily Cytheracea Baird, 1850
Family Cythereididae Sars, 1925
Genus Sanyuania Zhao & Han, 1980
(= Gamagyangnella Choe, 1988)

Emended diagnosis. Small; laterally compressed in dorsal
view with slightly pointed ends; subovate to subtriangular in
lateral view. Sexually dimorphic; female slightly higher than
male. Anterior margin broadly rounded, posterior margin
narrowly rounded to bluntly pointed, dorsal margin straight,
ventral margin with slight oral concavity. Greatest height at
anterior cardinal angle, greatest length well below mid-height;
ornament ranging from reticulate with posteroventral tuber-
cle to reticulo-costate with punta, to punctate or smooth.
Valves subequal along margins but RV slightly overhangs LV
along most of dorsal margin except at posterior cardinal
angle where LV overlaps RV. Eye spot inconspicuous. Normal
pore canals sieve type. Inner lamella of medium width, with
vestibula at each end; radial pore canals short, simple, few.
Hinge highly modified merodont in which the terminal ele-
ments alternate in a manner unique among the Ostracoda. In
the left valve the anterior terminal element is a positive
dentate bar while the posterior terminal element is a negative
loculate groove; these elements are connected by a smooth or
faintly denticulate bar; right valve hinge complementary. In
one species the anterior element of the left valve is smooth.
Adductor scars in oblique row of four, frontal scar U-shaped.

Type species. Sanyuania psaronius Zhao & Han, 1980
Distribution. Pliocene and early Pleistocene, central China;
Quaternary and Recent, eastern China; Recent, Korea.
Remarks. Sanyuania was recognized and systematically
described in manuscript by Huang more than 25 years ago
and remained unpublished until 1980. The generic and
specific names Sanyuania psaronius were applied by Zhao and
Han in 1980 but attributed to Huang, thus creating nomina
nuda. However, the description of the genus and its type
species by Huang (in Lin et al., 1982) served to validate these
nomina nuda but, unfortunately this results in the genus and
its type species being unascribable to Huang. The authors of
Sanyuania and of S. psaronius are by default, therefore, Zhao
and Han, 1980. The hinge of this genus was referred to by
Huang (in Lin et al., 1982) as amphidont, but our SEM illus-
trations in Pl. 1 clearly show it to be of highly modified merodont
type.
Gamagyangnella Choe, 1988 despite the fact that the anterior

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terminal element of its hinge was described as smooth, is clearly a junior synonym of Sanyuania.

**Sanyuania psaronius** Zhao and Han

(Pl.1, figs. 1-9)

1980 *Sanyuencia psaronius* Huang. Zhao and Han, Pl.1, fig.

1982 *Sanyuencia psaronius* Huang, in Lin et al., p.87, Pl.8, figs. 34-37

1983 Gen et sp.1, Hou et al., p.245, Pl.87, figs. 17-19.

1985 *Sanyuencia psaronius* Huang, Zhao et al., Pl.1, fig.10

**Diagnosis.** A reticulate species of *Sanyuencia* with a prominent, punctate posteroventral tubercle.

**Material.** More than 300 specimens. Figured specimens are all from Pleistocene core samples, Hole SX3, Changzhou, Jiangsu Province, China.

**Distribution.** Pliocene-early Pleistocene of the Fenwei Basin, central China, co-occurring with such brackish-water ostracods as *Callistocythere trokis* Huang, *Cyprideis torosa* (Jones), *Tanella liquens* Huang and the foraminifera *Ammonia tepida*. *Discorbis* sp. (Lin et al., 1982). In the Pleistocene and Holocene of coastal areas of eastern China, coexisting with euryhaline marine ostracods dominated by *Sinocytheridea impressa* (Brady), *Tanella opima* Chen and Spinileberis furuyaensis Ishizaki and Kato, and foraminifera dominated by *Ammonia beccarii* vars. and *Protelphidium glabrum* (Zhao and Han, 1980; Zhao et al., 1986) (Fig.1).

**Emended description.** Subtriangular, posterior margin slightly truncate above and narrowly rounded below. Surface reticulation with multangular fossae and delicately punctate solae. A small but prominent, punctate, rounded tubercle developed posteroventrally.

Sieve-type normal pore canals rounded and small. Inner lamella moderately wide with narrow vestibulae anteriorly and posteriorly.

Some 12 radial pore canals anteriorly and 8 posteriorly. Adductor scars in an oblique row.. Hinge of LV with a bar anteriorly bearing 3 large teeth; posteriorly the terminal element is a quadriloculate socket; median element a smooth bar with weak denticles anteriorly and posteriorly.

**Dimensions (mm)**

|   | length | height | width |
|---|--------|--------|-------|
| RV female OS13723 | 0.34    | 0.21   |       |
| LV male OS13724   | 0.31    | 0.17   |       |
| LV female OS13725 | 0.34    | 0.20   |       |
| LV female OS13726 | 0.33    | 0.20   |       |
| LV female OS13727 | 0.33    | 0.20   |       |
| Car. female OS13728| 0.32    | 0.21   | 0.24  |

**Fig. 3.** *Sanyuencia psaronius* sp. nov.

(Pl.1, figs. 1-9)

**Derivation of name.** Named in honour of Wang Qiang, Tianjin Institute of Geology & Mineral Resources, for his contribution to our understanding of the Quaternary Ostracoda of China.

**Material.** More than 20 specimens.

**Distribution.** Pleistocene and Holocene, coastal plain of eastern China (Fig.2). It always occurs with the two euryhaline marine ostracods *Sinocytheridea impressa*, *Leptocythere ventricilvosa* Chen and non-marine ostracods such as *Candonis* spp. and *Candoniella* spp.. The present species seems to be extinct but in the past to have lived in inland brackish water or supratidal environments of low salinity.

**Description.** Surface ornamented with weak concentric ribs and intercostal punctae which tend to merge into reticulation

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**Explanation of Plate 1**

**Fig. 1.** Distribution of *Sanyuencia psaronius* in China.

**Remarks.** Comparing the specimens figured in this paper with those from the type locality, near the city of Sanyuan, in the south of Shanxi Province, central China, which were kindly sent by Mrs. Huang who first encountered this species in 1970's, the authors found they are certainly conspecific. *S. psaronius* is readily distinguishable from all other species due to its reticulate surface and posteroventral tubercle.

**Sanyuencia wangii** sp. nov.

(Pl.1, figs. 1-9)

**Fig. 7.** Right valve, female (OS13729), from Xuzhou, Jiangsu Province, approx. lat. 34° 17' N, long. 117° 17' E, mid-Pleistocene, brown silty clay.

**Paratypes.** Nos. OS 13730-32 are all from Pleistocene core samples, Tianjiang.

**Material.** More than 20 specimens.

**Distribution.** Pleistocene and Holocene, coastal plain of eastern China (Fig.2). It always occurs with the two euryhaline marine ostracods *Sinocytheridea impressa*, *Leptocythere ventricilvosa* Chen and non-marine ostracods such as *Candonis* spp. and *Candoniella* spp.. The present species seems to be extinct but in the past to have lived in inland brackish water or supratidal environments of low salinity.

**Description.** Surface ornamented with weak concentric ribs and intercostal punctae which tend to merge into reticulation
centrally. All other characters as for genus except that the anterior socket of the RV has a delicate anti-slip bar ventrally.

### Dimensions (mm)

|          | Length | Height | Width |
|----------|--------|--------|-------|
| Holotype RV female OS13729 | 0.30   | 0.19   |       |
| Paratype car. male OS13730 | 0.30   | 0.17   | 0.13  |
| Paratype RV female OS13731 | 0.30   | 0.19   |       |
| Paratype Car. male OS13732 | 0.28   | 0.17   | 0.11  |

### Remarks

This species is most similar in lateral outline and internal features to *S. psaronius*, but differs in its costate and punctate surface and in lacking a posteroverentral node.

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*Sanyuania cuneata* sp. nov.

(Pl. 1, figs. 4-6)

**Derivation of name.** Latin. *cuneatus* = cuneate, wedge-shaped, with reference to the cuneate outline in lateral view.

**Diagnosis:** A species of *Sanyuania* characterized by its cuneate outline in lateral view, punctate surface ornament and compressed posterior margin.

**Holotype.** Carapace, male (OS13733), from a supratidal pool, off Xiangshangang Bay, Zhejiang Province, approx. lat. 29° 30'N, long. 121° 25'E, Recent, grey silt.

**Paratypes.** Nos. OS13734-5. All from shelf core samples, northern part of the Yellow Sea, late Pleistocene, clay.

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Materials. Seven specimens.

**Distribution.** Late Pleistocene and Recent, eastern China. Fossil specimens are from shelf core samples of the northern Yellow Sea, and Recent specimens from a supratidal pool with 17 o/oo salinity, Zhejiang Province (Fig.2).

**Description.** Elongate and cuneate in lateral view with sub-caudate posterior with posterodorsal slope truncated. Surface ornament of punctae which are sub-concentrically disposed and which decrease in size peripherally. The junction between the lateral and ventral surface is slightly sub-alar. Carapace markedly compressed along posteroverentral and posterior margins. Other characters as for genus.

**Dimensions (mm)**

|          | Length | Height | Width |
|----------|--------|--------|-------|
| Holotype Car. male OS13733 | 0.30   | 0.15   | 0.10  |
| Paratype car. male OS13734 | 0.32   | 0.17   |       |
| Paratype RV female OS13735 | 0.31   | 0.15   |       |

**Remarks.** By virtue of its elongate cuneate outline, punctate surface, compressed posterior margin and sub-alar structure, the present species differs from all other species of the genus.

*Sanyuania sublaevis* sp. nov.

(Pl. 2, figs. 8-14)

**Derivation of name.** Latin. *Laevis* = smooth, with reference to the nearly smooth surface of this species.

**Diagnosis.** Surface nearly smooth with very feeble ribs on end margins; normal pore canals large and very evident.

**Holotype.** Right valve, female (OS13736), from Jianghu County, Jiangsu Province, approx. lat. 32° 25'N, long. 119° 50'E, Holocene, clay; co-occurring with a rich ostracod fauna dominated by *Cocoonocythereinensis* Zhao and *Foraminifera* dominated by *Ammonia beccarii* vars.

**Paratypes.** Nos. OS13738-41; OS13737 was collected from the mouth of the Xiaoxinghe River, Recent; all others are from the type locality.

**Material.** More than 50 specimens.

**Distribution.** Holocene and Recent, eastern China. Living specimens were found in the estuary of a small river, the Xiaoxinghe River, Shandong Province, which flows into the Bohai Gulf, in a salinity of 0.5 - 1.3% (Fan, 1988, pers. comm.). Fossil specimens have been found from the coastal plain off the southern Yellow and the northern East China Seas, co-occurring with euryhaline ostracods and *Foraminifera*

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**Explanation of Plate 2**

Figs. 1-3, 7. *Sanyuania wangi* sp. nov.

Fig. 1, Holotype, RV, female (OS13729), mid-Pleistocene, Xuzhou, Jiangsu Province, ext. lat. X 153; Fig. 2, paratype, car. male (OS13730), LV lat. X 153; Fig. 3, paratype, RV, female (OS13731), int. lat. X 153; Fig. 7, paratype, car. male (OS13732), dors. lat. X 175; Figs. 2, 3 and 7, Pleistocene, Tianjin.

Figs. 4-6. *Sanyuania cuneata* sp. nov.

Fig. 4, paratype, RV, female (OS13734), Late Pleistocene, the Yellow Sea, ext. lat. X 144; Fig. 5, Holotype, car. male (OS13733), Recent, Xiangshangang Bay, Zhejiang Province, LV lat. X 153; Fig. 6, paratype, RV, male (OS13735), Late Pleistocene, the Yellow Sea, int. lat. X 142; Figs. 8-14. *Sanyuania sublaevis* sp. nov.

Fig. 8, paratype, car. female (OS13737), dors. lat. X 132; Fig. 9, paratype, LV, male (OS13738), ext. lat. X 132; Fig. 10, holotype, RV, female (OS13736), int. lat. X 132; Fig. 11, detail of RV hinge (OS13736), X 305; Fig. 12, paratype, RV, female (OS13739), ext. lat. X 132; Fig. 13, paratype, RV, male (OS13740), ext. lat. X 145; Fig. 14, paratype, LV, female (OS13741), int. lat. X 132.

Fig. 8, Recent, Xiaoxinghe River mouth; Figs. 9-14, Holocene, Jianghu County, Jiangsu Province.
Fig. 3. Possible evolutionary relationships within Sayunia.

such as Cocoonocythere sinensis Zhao, Sinocytheridea impressa (Brady), Spinileberis pulchra Chen and Ammobia beccarii vars., Protelphidium glabrum (Fig.2).

Description. Cardinal angles distinct in RV. Surface nearly smooth centrally but with a few feeble ribs anteriorly and posteriorly. Sieve-shaped normal pore canals large, rounded and very evident. Carapace in dorsal view with gently arched lateral margins and acutely pointed ends; greatest width centrally. Inner lamella moderately wide with relatively large terminal vestibulae; radial pore canals short, straight and simple, 10-12 anteriorly and 8-9 posteriorly. Other characters as for genus.

Dimensions (mm) length Height Width
Holotype RV female OS13736 0.35 0.21
Paratype car. female OS13737 0.34 0.19 0.15
Paratype LV male OS13738 0.32 0.17
Paratype RV female OS13739 0.35 0.22
Paratype RV male OS13740 0.32 0.18
Paratype LV female OS13741 0.35 0.20

Remarks. This species is characterized by its virtually smooth surface, which is shares with Sanyunia abei (Choe), 1988. The two species differ, however, in that the latter is more elongate and more pointed posteriorly.

DISCUSSION
Sanyunia is found only in the Pliocene to Recent central and eastern China and southern Korea. Of the five species reported above, S. psaronius is the oldest and the only one from the Pliocene-early Pleistocene. The first appearance of S. wangi is dated as early to mid-Pleistocene; and that of S. cuneata and S. sublaevis is late Pleistocene. S. abei is known only from the Recent. S. psaronius has a wide distribution from the central inland basin to the eastern coastal areas, while the other 3 Chinese species are limited to the eastern coastal areas. S. abei is apparently confined to Recent shallow seas off the southern coast of Korea.

It is probable that S. psaronius is the ancestral species of the genus, although relationships to an ancestral genus are unknown. The probable speciation patterns within the Sanyunia lineage is shown in Fig.3: S. wangi evolved from S. psaronius in the early Pleistocene, and subsequently in the late Pleistocene, S. cuneata and S. sublaevis evolved from either S. wangi or S. psaronius. The former is more likely given the observed similarity in ornament between these species. S. abei was almost certainly derived from S. sublaevis, probably late in geological time. The evolutionary sequence S. psaronius - S. wangi - S. cuneata - S. sublaevis - S. abei illustrated in Fig. 3, is also a morphological series illustrating a general reduction in strength of ornament with time from the robustly reticulate / punctate S. psaronius to the completely smooth S. abei.

During the Pliocene - Recent evolution of this genus, a trend of seaward migration through time takes place. In the Pliocene and early Pleistocene, S. psaronius occurred only in the inland brackish water basin of central China (Lin et al., 1982), but since the mid-Pleistocene all 4 Chinese species have been restricted to the coastal areas of eastern China where they have become one of the most common inhabitants of marginal marine environments, such as estuaries, lagoons and tidal marshes (Zhao & Han, 1980; Zhao et al., 1986). The Recent Korean species, S. abei, has become a typical marine form living in shallow seas with a depth range from 21.5 to 75m (Choe, 1988). S. abei is probably confined to the shallow
Sanyuuniu from China

Fig. 5. Distributionary area of two types of late Cainozoic brackish water ostracod faunas and approximate boundary between them. To the west is the Cyprideis type and to the east the Sinocytheridea type.

ern China are characterized by Albineberis, Cocoonocytcerhus, Sinocytherhus, Sanyunia, Sinocytheridea and Neosinocytherusk. These genera occur either only in China (the former 3) or mainly in China (the latter 3) (Zhao and Wang, 1988; Zhao and Whatley, 1989; Ishizaki, 1990). The ecological distribution of these genera is summarized in Fig. 4. Sinocytheridea is the most typical member of the fauna being the most widespread ecologically and geographically, and is abundant and ubiquitous in late Cainozoic brackish water faunas (Zhao and Han, 1980; Zhao et al., 1986; Zhao, 1985; Zhao and Wang, 1988; Li, 1985; Wang et al., 1988; and others). Sanyunia is one of the important elements of brackish water faunas especially in the Pliocene and early Pleistocene of central China where it often is the dominant genus. Compared with other regions of the world, the brackish water faunas of eastern China are unique. The most notable features is the absence of the worldwide euryhaline genus Cyprideis (Jones) from both fossil and modern brackish water faunas in eastern China. Cyprideis has only been found in western and central China where it occurs in brackish formations of Miocene to Holocene age and in modern salt lakes (Yang, 1981, 1988; Lin et al., 1982; Hao and Zhen, 1984; Xi et al.,). The Chinese late Cainozoic brackish water ostracod faunas, therefore, can be divided into two types: the western type characterized by the presence of Cyprideis, and the eastern type where Cyprideis is replaced by Sinocytheridea and other Chinese endemic genera. The boundary between the two types is located at the central part of China (Fig.5). The absence of the otherwise ubiquitous euryhaline genus Cyprideis from both fossil and Recent faunas of eastern China has been noted by Wang et al. (1985); Zhao and Wang (1988). They argued that mutual exclusion was caused by the similar ecological requirements of Cyprideis and its Chinese endemic competitors.

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