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Plio/Pleistocene Candonidae (Freshwater Ostracoda) from boreholes in The Nanning Area, Guangxi Province, Southern China

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ABSTRACT - Six cored boreholes in Guangxi Province, southern China yielded a fauna of Cypridacea as well as diverse Limnocytheridae which will be the subject of a separate publication. This paper deals only with the Cypridacea. Four species of *Candona* were present of which three are new, one previously described species of *Candoniella* (a controversial genus which is probably a synonym of *Candona*) and one new species of *Pontoniella*.

INTRODUCTION

Six out of nine cored boreholes drilled in the area round Nanning in Guangxi Province, southern China yielded non-marine faunas in the form of cypridacean and limnocytherid ostracods. This paper deals with the cypridacean part of the fauna. Preservation was generally good although, notably in the lower part of the X4 borehole between 120 and 126 metres, the calcified matrix in which these delicate valves were found made the ascertainment of the finer morphological details difficult.

Seven species of candonids were found including three new species of *Candona* and one of *Pontoniella*. One previously described species came from southwest China and the other from Central Asia. In view of the large number of species described from Europe it was somewhat disappointing that no European species could be recognised.

The Tiandong Borehole (X9), which lies some 150 kilometres from the other boreholes yielded only *Candoniella perisena* Jiang 1983. The other five boreholes all lie in the Nanning-Yongning area and contain good faunas except for the limited material of Yongning No.1 (X7). *Candona nanningensis* sp. nov. occurs in all five boreholes and is wide ranging. *Pontoniella praeceps* sp. nov. occurs in four of the five holes and, apart from an isolated occurrence at 121m in Nanning No.1, occurs in the upper part of the sections. *Candoniella perisena* Jiang 1983 occurs in the upper and middle parts of Nanning Nos. 1, 2 and 3. A species compared with *C. perisena* is found in the lowest parts of Nanning Nos. 1 and 2 and low down in Yongning No. 2 but preservation problems make detailed analysis of this form difficult and it would be unwise to place too much emphasis on it as an arbiter of the lower horizons. *Candona compressaeformis* Mandelstam 1963 occurs at a single hrizon in Nanning No. 1 and No. 2 and Yongning No. 2; *Candona posteroconica* sp. nov. also occurs in three holes, at single horizons in Nanning No. 1 and Yongning No. 2 and at two horizons in Nanning No. 3. *Candona guanxiensis* has only been found in two holes, at two horizons in Nanning No. 1 and at a single horizon in Nanning No. 2.

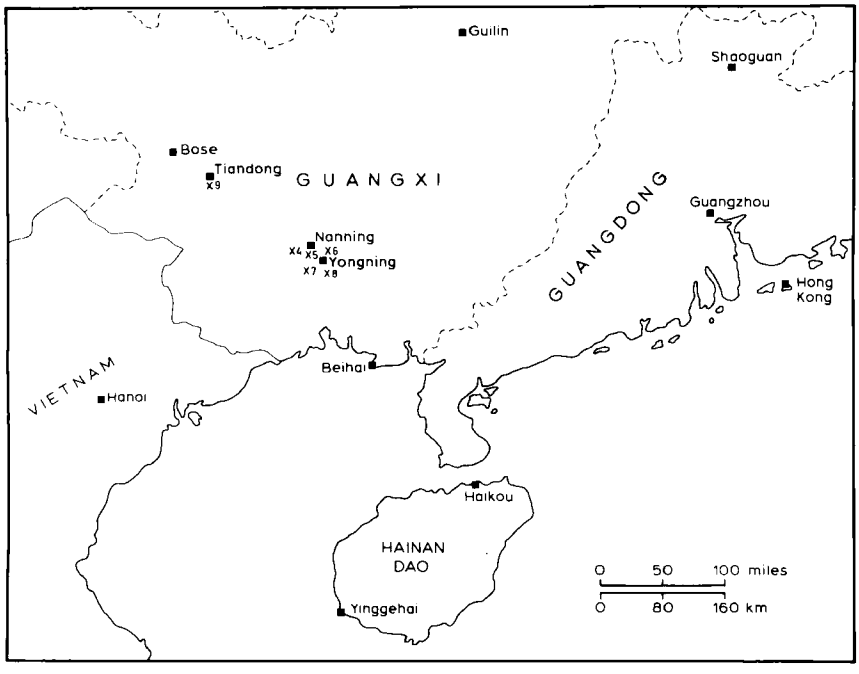


Fig. 1 Location of Boreholes in Guangxi Province, Southern China covered in this paper.

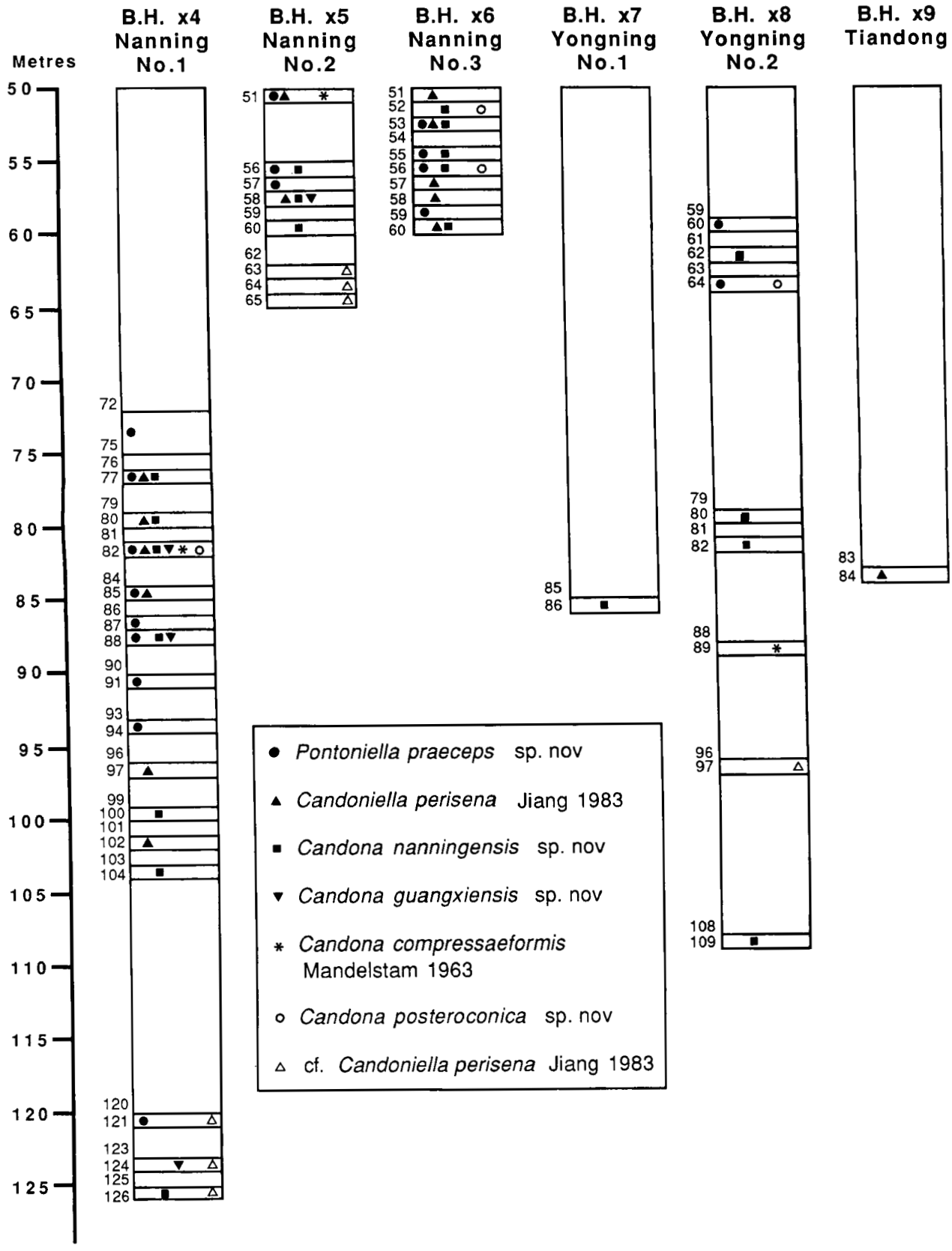


Fig.2 Distribution of Plio/Pleistocene Candonidae in Boreholes from Guangxi Province, S. China

Due to their fragility the faunas are not well enough developed to recognise more than tentatively an upper, middle and lower part in the sections based on the evidence outlined above. Upper, middle and lower parts may also be recognised, however, in the case of the Limnocytheridae where the fauna is more diverse and the correlation potential correspondingly greater.

The age of the material is suggested by a number of lines of evidence. Of the two previously described species, *Candona compressaeformis* Mandelstam 1963 was found in the Pliocene of Kazakhstan and *Candoniella perisena* Jiang 1983 in the Pleistocene of Southwest China. The new species are not helpful in this respect although their general aspect suggests Pliocene/Pleistocene affinities. The nature of the fauna provides some supplementary evidence. *Candona i*s confined to the northern hemisphere and favours cooler, more temperate waters. Its presence so far south suggests that conditions may have been cooler in the area at that time. This may be linked with the cooling that took place during the Pliocene and Pleistocene leading to the onset of glaciation in large parts of the northern hemisphere. Taken altogether the evidence suggests that the material is of Pliocene/Pleistocene age.

The environment was freshwater to oligohaline.

All material is deposited in the collections of the Academia Sinica, Institute of Geology in Beijing to which the specimen numbers refer.

SYSTEMATIC DESCRIPTIONS

Superfamily Cypridacea Baird, 1845
Family Candonidae Kaufmann, 1900
Subfamily Candoninae Kaufmann, 1900
Genus *Candona* Baird, 1845

Candona compressaeformis Mandelstam, 1963
(Pl. 1, figs 1, 2, 8)

1963 *Candona compressaeformis* Mandelstam, in Mandelstam & Schneider: p. 146, pl. XXI, fig. 13, Pl. XXIII, fig. 9.

Distribution. Depth
81-82m, Borehole X4, Nanning No. 1.
50-51m, Borehole X5, Nanning No. 2.
88-89m, Borehole X8, Yongning No. 2.

Dimensions of figured specimens.	Length	Height
Right Valve 9.9 (Pl. 1, fig. 1)	775µm	380µm
Left Valve 9.10 (Pl. 1, fig. 2)	715µm	375µm
Right Valve 9.1 (Pl. 1, fig. 8)	775µm	395µm

Remarks. Mandelstam's original material (length 990µm) came from the Pliocene Akchagylsk Stage of Kazakhastan and the two are virtually identical except for the smaller size (length 775 µm) of the Nanning specimens.

It is not close to any of the Early Tertiary coastal forms from the Bohai Region and although *C. aequalis* Li & Lai (1978, pl. 44, figs. 2-4) is the nearest, the latter differs in its much steeper posterior margin and far greater size (length 1330µm, 1500 µm).

The Chinese specimens are fairly close to *C. annae* Mehes, 1913 as figured by Keyser (1976, pl. 7, figs 6,7) from SW Florida although not so concave ventrally and less narrow in the anterior part which is also not set at such a marked angle to the length. Keyser's material is also larger (0 960-1060 µm; 0 1000-110 µm).

The present material differs from *C. (Cryptocandona) vavrai* (Kaufmann), as figured by Sywula (1974, pl. IV, a,b) in his work on the Polish fauna, in its less angular antero-dorsal margin. Sywula's specimens are slightly larger (850-930 µm). *Candona triebeli* Krstic 1972 is somewhat similar but is more elongate in proportion to the length, is not so high anteriorly and is larger (length 1090-1360µm).

The Nanning specimens are fairly close to *C. kirgizica* Mandelstam 1963 from the Xining and Minhe basins (Hao *et al.*, 1983, pl. 12, figs 17a, 18) although the latter tapers too much in side view. The present material differs much more from the material of *C. kirgizica* figured by Mandelstam (1963, pl. XXII, figs 8,9) from the Pliocene of the Alakyul Region, Kirgiziya. *C. rectangulata* Hao 1974 (pl. 27, fig. 1c) differs in its much steeper postrerior margin and *C. disjuncta* Hao 1974 (pl. 26, fig. 5) differs in its greater elongation.

Other species are not close.

Candona (Fabaeformiscandona) nanningensis sp. nov
(Pl. 1, figs 3-6)

Derivation of name. In reference to its occurrence in the Nanning borehole.

Diagnosis. A species of *Candona* with greatest length at mid-height. Dorsal and ventral margins parallel with only slight concavity in the middle of the ventral margin and very straight postero-dorsal margin which begins at two-thirds length. Anterior margin evenly rounded.

Holotype. A Right Valve No. 9.6 Length 875µm, Height 400 µm.

Type Horizon. Depth 81-82m., Borehole X4, Nanning No. 1.

Other Horizons. 76-77m, 79-80m, 81-82m, 87-88m, 99-100m, 103-104m and 125-126m, Borehole X4, Nanning No. 1.
55-56m, 57-58m, 59-60m, Borehole X5, Nanning No.2
51-52,. 52-53,. 54-55,. 55-56,. 50-60m Borehole X6, Nanning No.3.
85-86m, Borehole X7, Yongning No. 1.
61-62m, 79-80m, 81-82m, 108-109m Borehole X8, Yongning No.2.

Description.
For description see diagnosis and stereographic photographs.

Dimensions of figured specimens.	Length	Height
Holotype, Right Valve 9.6 (Pl. 1, fig. 3)	875 µm	400µm
Left Valve 9.2 (Pl. 1, fig. 4)	915µm	425µm
Left Valve 9.7 (Pl.1, fig. 5)	945µm	450µm
Right Valve 9.3 (Pl. 1, fig. 6)	850µm	390µm

Remarks. *C. nanningensis* shows similarities to a number of species already described. In 1978 Guan (p. 193, pl. 49), figs 5, 6) described *Candona cyrtoformis* from Oligocene deposits of South Central China. This agrees well in size (875-900 µm) and general shape but has a shorter, straighter postero-dorsal margin, does not taper quite so much posteriorly and in the left valve the maximum length is lower. On the other hand the line figure (p. 193) is quite different posteriorly with a break in slope in the straight part and a less cut away postero-dorsal part. *Candona sinuosa* Yang, Hou & Huang (1982, 71, pl. 17, figs 8-13) from the Quaternary of the Jiangsu Basin is comparable in size with a length of 800 to 1080 µm. It is generally fairly close but the postero-ventral margin is too rounded in all the original figures. It approaches the present situation more in the figure by Wang Pinxian in *The Marine Micropalaeontology of China* (1985, pl. 27, fig. 14) but his specimen is much more elongate.

Candona habros Hao 1974 figured in Hao *et al.* (1983, pl. 12, fig. 4) from the Xining and Minhe basins is fairly close in shape although the correspondence is not exact. In Hao's species the maximum length (junction of straight postero-dorsal margin and curved postero-ventral margin) is higher but on the whole very near to the situation in our species. However, in his material the dorsal margin is more vaulted, the shell is less elongate and is much smaller - length 680µm. Hao's original material was even smaller (length 600µm). In the present species the height also tends to be maintained more anteriorly.

C. nanningensis shows considerable affinities with the *Candona fabaeformis* group and is fairly close to *C. fabaeformis* of the Polish fauna figured by Sywula (1974, 283, pl. V, figs a-c) but the present species tapers less anteriorly. *Candona (Fabaeformiscandona)* aff. *krstici* Petkovski 1969 as figured by Krstic (1972, p. 93-4, pl. XXIX, (figs 5,6) is probably closest and with its given length of 880-960 µm it also agrees well in size. In Petkovski's species the postero-ventral margin appears to be more broadly rounded.

Candona guangxiensis sp. nov.
(Pl. 1, fig. 7)

Diagnosis. A species of *Candona* with the greatest height at the mid-length, posterior of which the straight dorsal margin falls gently to the posterior cardinal angle at three-quarters length and then steeply to the posterior termination at about one-third height. Anterior half of dorsal margin straight, sloping gently anteriorly where it joins the evenly rounded anterior margin. A gentle concavity occurs in the middle of the ventral margin.

Holotype. A Right Valve No. 9.11 Length 1100µm, Height 550µm.

Type Horizon. Depth 87-88m, Borehole X4, Nanning No. 1.

Other Horizons. 81-82m, 123-124m, Borehole X4, Nanning No. 1.

57-58m, Borehole X5, Nanning No. 2.

Dimensions of figured specimen	Length	Height
Holotype, Right Valve 9.11 (Pl. 1, fig. 7)	1100µm	550µm

Other material varies in length from 750 µm to 1015 µm.

Remarks. The present species is close to *Candona protensa* Li & Lai (1978 pl. 38, fig. 13). In the present material the posterior margin has a straighter and steeper slope and the highest part of the valve lies in the middle of the dorsal margin, whereas in *C. protensa* the highest part occurs at the posterior cardinal angle. It is also quite close to *C. bellula* Yang 1982 in Hao *et al.* (1983, 71, pl. 12, fig. 19) from the Xining and Minhe basins but *C. bellula* has a longer, steeper fall antero-dorsally, the postero-dorsal margin is less straight and it tends to be higher at the postero-dorsal corner.

The closest comparison in material figured from the Cretaceous-Quaternary of Jiangsu (1982) appears to be *Candona (Lineocypris) lubrica* Chen & Ho (pl. 19, fig. 9) whose length ranges from 920 to 1090 µm. The resemblance is probably accidental since it does not compare closely with the other figured specimens and especially with their pl. 19, figs 1-6. In general *C. lubrica* has the greatest height at the posterior cardinal angle whereas in our species it lies at the mid-length.

None of the species figured by Krstic (1972) in her monograph on the genus *Candona* show any resemblance to this species.

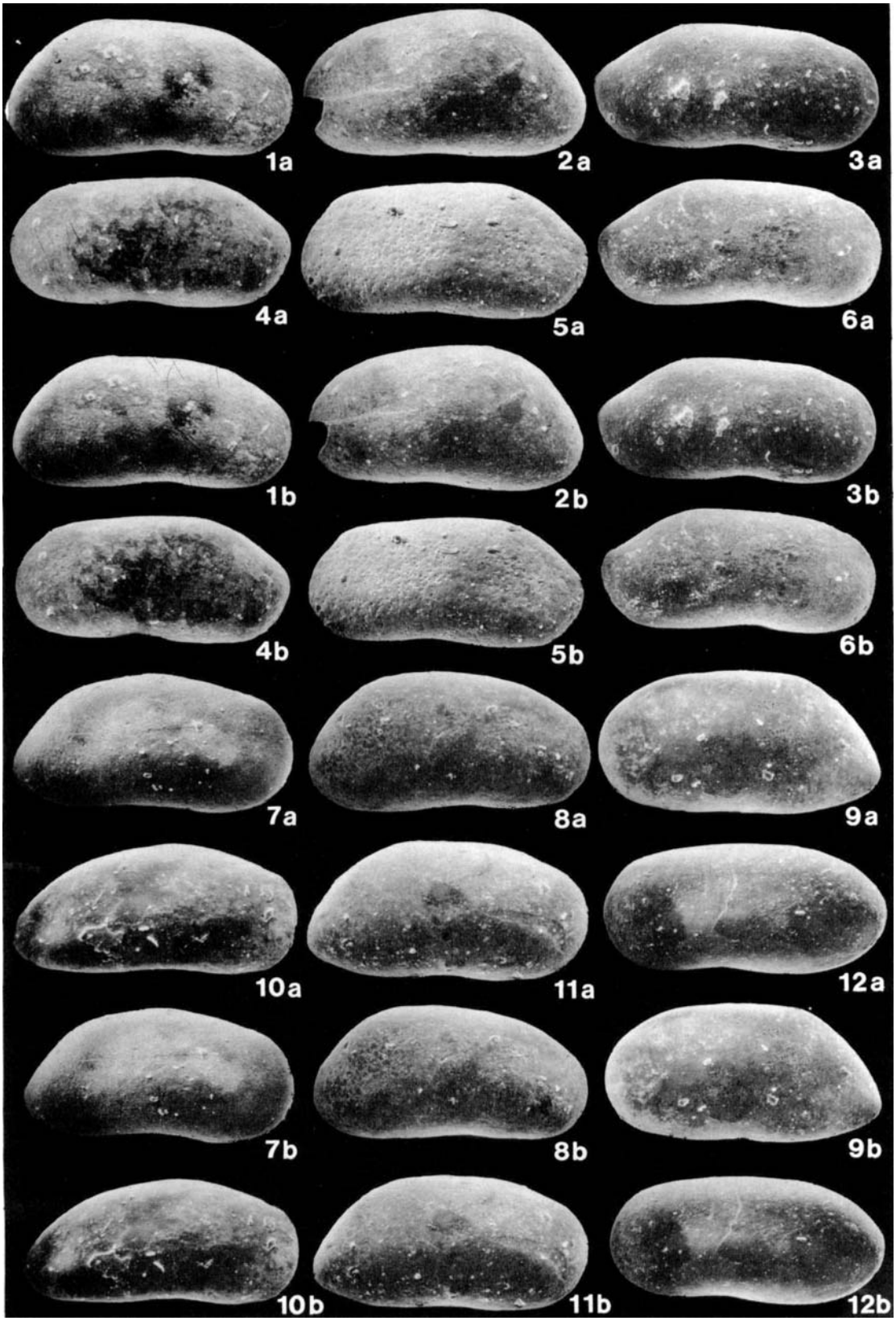
Candona (Sirmiella?) posteroconica sp. nov.
(Pl. 1, figs 9,11)

Derivation of name. A reference to its distinctive shape posteriorly in side view.

Diagnosis. A species of *Candona* with subparallel dorsal and ventral margins, evenly rounded anterior margin, only slight concavity in the median part of the ventral margin but with very distinctive posterior termination, the gently convex postero-

Explanation of Plate 1

Paired stereographic photographs. External lateral views. All material from Borehole X4, Nanning No. 1, Nanning, Guangxi Province, China.
Figs 1, 2, 8. *Candona compressaeformis* Mandelstam 1963. Depth 81-82m; Fig. 1. Right Valve No. 9.9, X61; Fig. 2. Left Valve No. 9.10, X66; Fig. 8. Right Valve No. 9.1, X61.
Figs 3-6. *Candona nanningensis* sp. nov. Fig. 3. Holotype, Right Valve No. 9.6, Depth 81-82m, X54; Fig. 4. Left Valve No. 9.2, Depth 81-82m, X51; Fig. 5. Left Valve No. 9.7, Depth 76-77m, X50; Fig. 6. Right Valve No. 9.3, Depth 81-82m, X55.
Fig. 7. *Candona guanxiensis* sp. nove., Holotype, Right Valve No. 9.11, Depth 87-88, X43.
Figs 9,11. *Candona (Sirmiella?) posteroconica* sp. nov. sp. 6, Depth 81-82m. Fig. 9. Holotype, Left Valve No. 9.4, X61; Fig. 11. Right Valve No. 9.5, X62.
Fig. 10. *Pontoniella praeceps* sp. nov., Holotype, Right Valve No. 9.8, Depth 76-77m, X70.
Fig. 12. *Candoniella perisena* Jiang, 1983. Left Valve No. 9.13, Depth 101-102m, X72.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dorsal and postero-ventral margins forming a symmetrically conical termination to the shell at approximately one-quarter height.

Holotype. A Left Valve No. 9.4 Length 775 μm, Height 395 μm.

Type Horizon. Depth 81-82m, Borehole X4, Nanning No. 1.

Other Horizons. 51-52m, 55-56m, Borehole X6, Nanning No. 3.
63-84m, Borehole X8, Yongning No. 2.

Dimensions of figured specimens.	Length	Height
Holotype Left Valve 9.4 (Pl. 1, fig. 9)	775μm	395μm
Right Valve 9.5 (Pl. 1, fig. 11)	755μm	370μm

Description. See Diagnosis and stereographic figures.

Remarks. In her detailed work on the candonids, Krstic (1972) recognised a number of new subgenera including *Sirmiella* which she differentiated from *Caspiolla* by a number of features including their generally smaller size. The present material agrees fairly well with her interpretation of this taxon. However, the posterior termination of our species is less downturned than in typical *Sirmiella* and so is only tentatively referred to this subgenus. Among Krstic's species our species is closest to *C. (S.) sirmica* Krstic (1972, pl. VII, figs 6-9) but differs from the latter in its sharper and slightly higher posterior termination of the shell in side view. *Candona (Lineocypris) pallida* Chen & Ho sp. nov., in Hou *et al.* 1982 (pl. 20, figs 1-8) is similar but differs in having the greatest height at the anterior, not the posterior cardinal angle. The right valve also shows a considerable resemblance to Lienenklaus's *C. recta* Lienenklaus 1905 from the Lower Miocene of Germany especially in the nature of the posterior termination and its size (800μm but our specimens are more rounded anteriorly and not quite so accentuated in height at the posterior cardinal angle. It is also similar to the Upper Oligocene *Candona candidula* being virtually identical in size, but the left valve in that species is very different with a much lower posterior termination. Another somewhat similar species, *C. balatonica* Daday *affinis* Zalanyi 1959 also has a lower posterior termination and is much bigger (1120μm). The large (1220μm) Oliocene/Pleistocene C. *chosei.* Dickinson & Swain 1967 is much more concave ventrally. Other species are not close.

Genus *Candoniella* Schneider, 1956

This was regarded as a doubtful genus in the Treatise (Moore 1961) and the type species was firmly placed as a synonym of *Candona* by Hartmann & Puri (1974). Jiang's species represents a well known group of species which are usually placed in Schneider's genus. This group should probably be recognised as a subgeneric grouping in *Candona.* Meanwhile we have here retained Jiang's original combination.

Candoniella perisena Jiang, 1983
(Pl. 1, fig. 12)

1983 *Candoniella perisena* Jiang (sp. nov.) in Li Yu-Wen *et al.*, 93, pl. 28, figs 5,6.

Distribution. Depths 76-77m, 79-80m, 81-82m, 84-85m, 96-97m and 101-102m, Borehole X4, Nanning No. 1.
50-51m, 57-58m, Borehole X5, Nanning No. 2.
50-51m, 52-53m, 56-57m, 57-58m, 59-60m, Borehole X6, Nanning No. 3.
83-84m, Borehole X9, Tiandong.

Dimensions of figured specimen	Length	Height
Left Valve 9.13 (Pl. 1, fig. 12)	650 μm	305 μm

Remarks. The present material (length 650-670 μm) agrees well in size and shape with Jian's Pleistocene species (630-650 μm). As figured by Mandelstam & Schneider (1963, pl. XXVII, fig. 6) *C. Pellucida* Schneider differs in the posterior termination of the shell as seen in lateral view and in its greater size (750 μm). *Candoniella extensa* Shi & Yan (1978, pl. 47, fig. 17) from the Oligocene of the coastal region of Bohai differs in its more rounded posterior termination and greater size (length 870 μm). *Candoniella tianzhuangtaiensis* Shi & Si 1978 (pl. 48, fig. 8) also from the Oligocene of the coastal region of Bohai is somewhat similar but differs posteriorly; its greatest length is below mid-height and the species is slightly larger (length 760 μm).

Jiang's original specimens came from the Pleistocene Yangling Formation of Songmin, Yunnan Province.

cf. Candoniella perisena Jiang, 1983

In the lower part of Boreholes X4, X5 and X8 delicate valves occur in a calcified matrix. This makes it difficult to ascertain their shape and morphology accurately. They probably belong in Jiang's species but at present they are only tentatively referred here.

Horizons. Depths 120-121m, 123-124m, 125-126m, Borehole X4, Nanning No. 1.
62-63m, 63-64m, 64-65m, Borehole X5, Nanning No. 2.
96-97m, Borehole X8, Yongning No. 2.

Subfamily Disopontocypridinae Mandelstam 1956

Genus *Pontoniella* Mandelstam 1956

Mandelstam established this genus with *Paracypria acuminata* Zalanyi 1929 as the type species. Zalanyi (1929, 57-61, figs 23, 24) gave good figures of this showing the typical elongate triangular shape and the main muscle scar pattern which consists of a rosette of five scars with an elongate scar above. The hinge is simple, the dorsal margin of the right valve fitting into a groove below the margin of the left valve. Anteriorly the left valve margin expands slightly to form a characteristic small overhanging flange well figured by Mandelstam & Schneider (1963, 85, fig. 81). Our specimens agree well with all these features and fit well in this genus. The genus *Subulacypris* Schneider 1957, which agrees quite well in shape with the Guangxi material and whose type species comes from the Quaternary of northern China, was considered but rejected on account of its very wide inner lamellae and the lack of a marginal expansion of the left valve dorsal margin anteriorly

to form a small flange. Krstic (1971) treats *Pontoniella* as a subgenus of *Candona* and lists the species which she considers to belong in it. The differences from *Candona* appear to justify the full generic status which is adopted here.

The genus is typically Pannonian (late Miocene) to Recent in age and best known from the Pontian of Europe.

Pontoniella praeceps sp. nov.
(Pl. 1, fig. 10)

Derivation of name. *praeceps* L. steep, in reference to the steep anterior margin in side view.

Diagnosis. A species of *Pontoniella* whose anterior margin is steep and very widely rounded, meeting the antero-dorsal margin in a distinct, obtuse angle. Greatest height lies at about one-third the length and posteriorly the valve ends in a blunt point giving the greatest length at about one-sixth height.

Holotype. A Right Valve No., 9. 8 Length 660 μm, Height 305 μm.

Type Horizon. Depth 76-77m, Borehole X4, Nanning No. 1.

Other Horizons. 72-75m, 81-82m, 84-85m, 86-87m, 87-88m, 90-91m, 93-94m, and 120-121m, Borehole X4, Nanning No. 1.
50-51m, 55-56m, 56-57m, Borehole X5, Nanning No. 2.
52-53m, 54-55m, 55-56m, 58-59m, Borehole X6, Nanning No.3.
59-60m, 63-64m, Borehole X8, Yongning No. 2..

Description. The inner lamella is fairly broad anteriorly and forms a smaller, crescentic vestibule postero-ventrally. The marginal areas are narrow with fine, straight, densely-packed marginal pore canals which number about 50 anteriorly. The central muscle scar pattern consists of a compact cluster of four or five scars with an elongate scar dorsally. Some specimens appear to show an additional elongate scar above the latter. External features are adequately covered by reference to Pl. 1, fig. 10.

Dimensions of figured specimen	Length	Height
Holotype Right Valve 9.8 (Pl. 1, fig. 10)	660μm	305μm

Remarks. The closest European species is *Candona (Pontoniella) paracuminata* Krstic (1968), a new taxon set up to accommodate the Upper Pontian material from the Pejinovic area of Serbia placed in *Paracypria acuminata* by Zalanyi (1929). Krstic's figures (1971, pl. 1, figs 9-11) show a good general correspondence but a more prominent posterior cardinal angle and sharper posterior point in side view. The Caucasus specimens figured by Mandelstam & Schneider (1963, pl. VI, figs. 1,2) as *Pontoniella acuminata* (Zalanyi) are also close but again have a sharper posterior termination in side view. *Candona (Pontoniella) glabra* Krstic (1969, 728-9, pl. 1, figs 6 7) from the Pontian of Kladovo differs most notably in its greater height at the posterior cardinal angle. Krstic's line drawings give a good representation of the internal structures.

Differences from the genus *Subulacypris* have been dealt with above but some forms included in this genus resemble the present species and the genus is well known from the Miocene, and especially Pliocene and later rocks in China and the USSR. Among Soviet species, *S. gubkini* Mandelstam 1962 (in Mandelstam & Schneider) from the Upper Sarmatian (Upper Miocene) of the Caucasus is the closest. This differs in being higher in proportion to the length and in having the anterior margin more rounded in lateral view.

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