

# Reassessment of *Cambaroides dauricus* and *C. schrenckii* (Crustacea: Decapoda: Cambaridae)

Tadashi Kawai\*, Yoichi Machino<sup>1</sup>, and Hyun Sook Ko<sup>2</sup>

Hokkaido Nuclear Energy Environmental Research Center, Miyaoka 261-1, Kyowa, Hokkaido 045-0123, Japan;

<sup>1</sup>13 Rue Montorge, F-38000 Grenoble, France;

<sup>2</sup>Department of life Science, Silla University, Busan 617-736, Korea

## Key Words:

Reassessment

Morphology

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*Cambaroides wladivostokiensis*

*Cambaroides dauricus*

*Cambaroides koshewnikowi*

*Cambaroides sachalinensis*

*Cambaroides schrenckii*

Taxonomic confusion has been presented within freshwater crayfishes of the genus *Cambaroides* since Starobogatov published morphological definition and revision of the group in 1995. He suggested that *Cambaroides* should be revised: the *C. dauricus* contained three species *C. dauricus*, *C. wladivostokiensis*, and *C. koshewnikowi*; the *C. schrenckii* with two species *C. schrenckii* and *C. sachalinensis*. Also Starobogatov did not take into account the previous data of crayfish distributions. In order to clear up the confusion, the taxonomy of crayfish sampled from Mongolia, Russia, China, and North Korea was reassessed. Starobogatov's key could not lead to the correct identification. Also, detailed observations of apical robe of the male first pleopod did not support the taxonomy on the genus *Cambaroides* proposed by Starobogatov in 1995. However, some local variations of morphology exist in rostrum, pleuron, and telson of Asian crayfish. Future studies should be concentrated on whether there are geographical clines of morphology or if taxonomic subdivision is necessary.

The East-Asian freshwater crayfish genus *Cambaroides* comprises four species: *C. japonicus* (De Haan, 1842) in Japan; *C. similis* (Koebel, 1892) in South Korea, North Korea, and China; *C. dauricus* (Pallas, 1772) in China, Russia, and North Korea; *C. schrenckii* (Kessler, 1874) in China and Russia (Pallas, 1772; Faxon, 1885; Koba, 1939, 1942).

Starobogatov (1995) revised the taxonomy of the Far-East Asian freshwater crayfish. The details of his study are based on the Birstein and Winogradov (1934), who divided *C. dauricus* into three subspecies *C. d. wladivostokiensis*, *C. d. dauricus*, and *C. d. koshewnikowi*, and *C. schrenckii* into two *C. s. sachalinensis* and *C. s. schrenckii*. Using only Russian specimens, Starobogatov (1995) elevated those subspecies to full species and provided a key to the *Cambaroides* members, which was mainly based on the morphology of rostrum, pleuron, and telson. His opinion was also cited in an important book (Vasilenko and Starobogatov, 1995). However, Fitzpatrick (1997) strongly pointed out several mismatching facts between Starobogatov's opinion and the modern taxonomy of freshwater crayfish. For example, Starobogatov gave no attention to the details of the apex of male first pleopod, a frequently used character

for the taxonomy of the genus. In the present paper we examine the credibility of Starobogatov's opinion through observation of specimens from Mongolia, Russia, China, and North Korea.

## Materials and Methods

Forty crayfish specimens were examined. They came from Natural History Museum and Institute in Chiba (CBMI), Zoological Institute of Hokkaido University (ZIHU), the Naturhistorisches Forschungsinstitut Museum für Naturkunde zu Berlin (ZMB), Tokyo University of Fisheries, and our field collections near Khabarovsk, Russia (Fig. 1 and Table 1, localities from A to J).

The following measurements were taken: postorbital carapace length (CL), measured from the posterior portion of the eye socket to the posterior margin of the carapace; rostral length (RL); rostral width (RW); telson length (TL); and telson width (TW) (Fig. 2). Illustrations were prepared with the aid of a drawing tube mounted on an Olympus SZH stereomicroscope.

## Literature Review

Taxonomic subdivision of the group *Cambaroides dauricus* into three subspecies (*C. d. wladivostokiensis*, *C. d. dauricus*, and *C. d. koshewnikowi*) and the group *C. schrenckii* into two (*C. s. sachalinensis* and *C. s.*

\*To whom correspondence should be addressed.

Tel: 81-135-74-3131, Fax: 81-135-74-3135

E-mail: kawaita@fishexp.pref.hokkaido.jp



Fig. 1. Map showing the sampling localities of crayfish examined. Alphabetical letters correspond to the localities in Table 1 and Fig. 4 & 5. Dotted area denotes Kumarovian Province defined by Starobogatov (1995).

*schrenckii*) was proposed by Birstein and Winogradov (1934). As new taxa, they described *C. d. wladivostokiensis* from the basin of the Peter the Great Bay (Sedanka, Chernaya Rechka, Sungfun (=Suifun rivers)) as well as from tributaries of the Mudan River in China (around Hangdao (=Hengdaohezi), Shanshi, and Shitou rivers) and *C. d. koshewnikowi* from freshwater

parts of the Tatar Strait, i.e. Amur Liman at Pronge (Nikolaevsk na Amure, Pronge, and the mouth of the Amur rivers). *C. s. sachalinensis* had been suggested by Klumow but that work went unpublished (Birstein and Winogradov, 1934), and the work of Birstein and Winogradov (1934) was indeed the first description of *C. s. sachalinensis* from rivers flowing into the Amur Liman

Table 1. Samples of Asian crayfish in mainland (Mongolia, Russia, North Korea, and China)

Locality	Date	Number	CL (Range )	Deposit
A, Mongolia Onon River	1993, Aug. 03	♀	20.6 mm	CBM ZC 5187
B, Russia Bal'zina	?	♂	30.9 (29.0-32.6)	ZMB 3862
C, Russia Khabarovsk	2001, Oct. 02	♂	32.9 (25.2-37.4)	Our collection
C', Russia Khabarovsk	2001, Oct. 02	♂ ♀	25.1 (17.3-30.3)	Our collection
D, Russia Ussuriysk	1995, Aug. 09	♂ ♀	20.0 (13.7-27.6)	CBM ZC 1978
E, North Korea Hoeryong	1929, Sep. 25	♂ ♀	22.8 (15.3-30.5)	Tokyo University of Fisheries
F, North Korea Yalu River	?	♂	24.4	Tokyo University of Fisheries
H, China Harbin	1937, ? ?	♂ ♀	21.5 (16.5-25.0)	ZIHU 4130
I, China Yanji	2001, Aug. 14	♂ ♀	27.1 (24.5-28.8)	CBM ZC
J, China Fusong	2000, July, 18	♂ ♀	24.5 (22.2-27.3)	CBM ZC 5703
G, China Tangyuan	1941, July, ?	♂ ♀	23.6 (21.4-27.4)	CBM

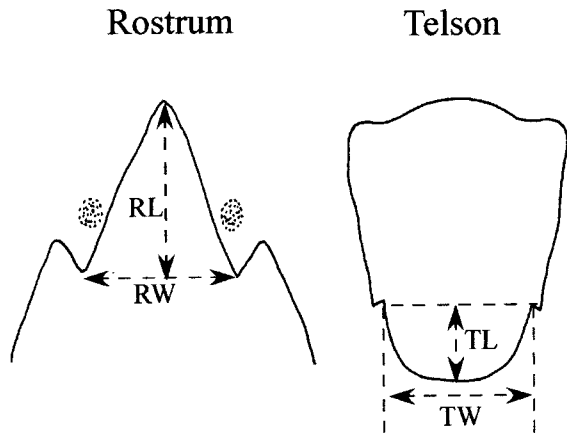


Fig. 2. Size measurements and terms used in the present study.

in northern Sakhalin. Type localities of these taxa are as follows:

- C. d. wladivostokiensis* - type locality: Sedanka, Chernaya Rechka, Suifun, Hengdaohezi, Shanshi, and Shitou, China.
- C. d. koshewnikowi* - type locality: Nikolaevsk na Amure, Pronge, and the mouth of the Amur, Russia.
- C. s. sachalinensis* - type locality: rivers flowing into the Amur Liman in northern Sakhalin, Russia.

Hence, *C. d. dauricus* is confined to the upper Amur

areas but *C. s. schrenckii* occurs widely in the Ussuri drainage and the lower Amur areas as well as one lake near village Grigor'evka in northern Sakhalin (Birstein and Winogradov, 1934). In his revision of the *C. dauricus* and *C. schrenckii* groups (Starobogatov, 1995) these subspecies were elevated to the specific level. Also he re-defined the type locality for *C. schrenckii* (sensu Starobogatov) as the Songhua River (=Sungari River, outlet of Khanka Lake) and the mouth of the Ussuri River near Khabarovsk.

Although Starobogatov (1995) failed to recognize its presence in the Chinese Amur drainage, *C. d. wladivostokiensis* was well known in the Songhua (=Sungari) drainage in China to Birstein and Winogradov (1934) and Winogradov (1950). Secondly, the presence of *C. d. dauricus* (sensu Birstein and Winogradov) around Khabarovsk (Timm, 1991) seemed to be ignored by Starobogatov (1995). Finally, records for *C. dauricus* and *C. schrenckii* from Chinese and Korean territories (Okada, 1933; Koba, 1939, 1942; Kim, 1977) were also neglected by Starobogatov (1995). He "adjusted" the geographical distribution patterns for *C. dauricus*, *C. schrenckii*, and *C. wladivostokiensis*. And Starobogatov (1995) spelled *C. wladivostokensis* and *C. schrencki* inaccurately.

### Results and Discussion

The character states following Starobogatov (1995) (Fig. 3) for specimens examined are shown in Table 2. With

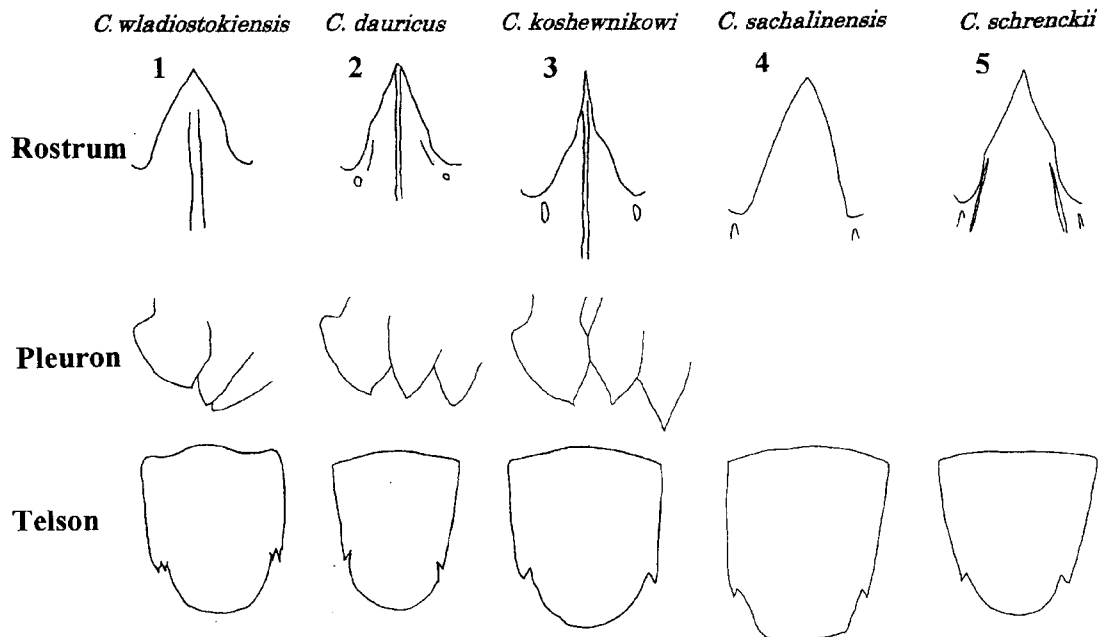


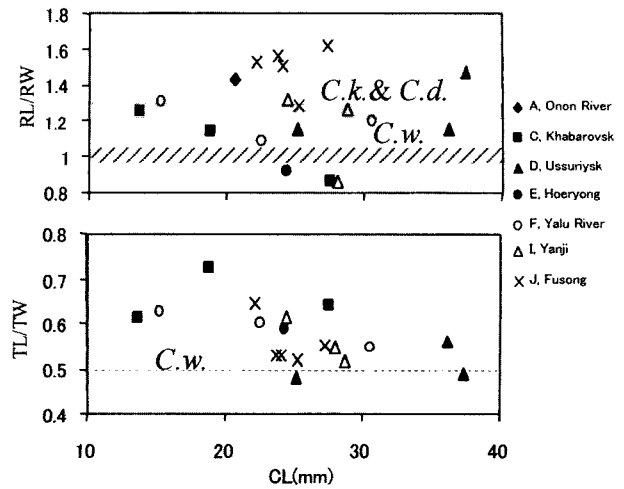
Fig. 3. Definition of the Far-East Eurasian species of *Cambaroides* members by Starobogatov (all redrawing are reproduced from Starobogatov, 1995). Rostrum; 1, triangular; 2, sub-triangular; 3, narrowed in the middle part; 4, triangular with apical angle not exceeding 50°; 5, lancet-shaped; Pleuron; 1, with obtuse at ventral end; 2, wedge-shaped and blunt; 3, acute and second somite with short spine; Telson; 1, posterior part about half as long as width; 2, lateral margin clearly convergent; 3, almost paralleled or insignificant convergent; 4, caudal margin truncate; 5, round.

**Table 2.** Location and character states of examined specimens. Five different species were identified by the characters sets (Rostrum, Pleuron, and telson) based on Fig. 3

Locality	CL (mm)	Sex	Rostrum	Pleuron	Telson
A. Mongolia, Onon River	20.6	♀	2	1	–
B. Russia, Bal'zina	32.6	♂	3	3	2
B. Russia, Bal'zina	31.9	♂	3	3	2
B. Russia, Bal'zina	31.7	♂	3	3	2
B. Russia, Bal'zina	29.5	♂	3	3	2
B. Russia, Bal'zina	29.0	♂	3	3	2
C. Russia, Khabarovsk	37.4	♂	1	1	2
C. Russia, Khabarovsk	36.2	♂	1	1	2
C. Russia, Khabarovsk	25.2	♂	1	1	2
C'. Russia, Khabarovsk	30.3	♀	–	5	4
C'. Russia, Khabarovsk	28.3	♀	–	4	5
C'. Russia, Khabarovsk	27.3	♀	–	5	4
C'. Russia, Khabarovsk	25.6	♂	–	4	4
C'. Russia, Khabarovsk	21.7	♂	–	5	5
C'. Russia, Khabarovsk	17.3	♀	–	5	5
D. Russia, Ussuriysk	27.6	♀	2	1	3
D. Russia, Ussuriysk	18.8	♂	2	1	2
D. Russia, Ussuriysk	13.7	♂	2	1	2
E. North Korea, Hoeryong	30.5	♂	2	1	3
E. North Korea, Hoeryong	22.5	♀	2	1	3
E. North Korea, Hoeryong	15.3	♂	2	1	3
F. North Korea, Yalu River	24.4	♂	2	1	2
H. China, Harbin	25.0	♀	1	1	2
H. China, Harbin	24.3	♀	1	1	2
H. China, Harbin	23.8	♀	2	1	2
H. China, Harbin	22.3	♀	1	1	2
H. China, Harbin	21.2	♂	1	1	2
H. China, Harbin	17.1	♂	1	1	2
H. China, Harbin	16.5	♂	1	1	2
I. China, Yanji	28.8	♂	3	1	2
I. China, Yanji	28.0	♀	3	1	2
I. China, Yanji	24.5	♀	2	1	2
J. China, Fusong	27.3	♀	3	1	2
J. China, Fusong	25.3	♂	3	1	2
J. China, Fusong	24.1	♀	3	2	2
J. China, Fusong	23.8	♀	3	1	2
J. China, Fusong	22.2	♂	3	2	2
G. Tangyuan	27.4	♂	–	5	5
G. Tangyuan	21.9	♀	–	4	4
G. Tangyuan	21.4	♂	–	4	5

–: not measured.

his key it was impossible to reach the correct identification of taxa *wladiostokiensis*, *dauricus*, *koshewnikowi*, *sachalinensis*, and *schrenckii*. None of crayfish specimens from these localities agrees with morphology of any single taxon defined by Starobogatov. According to Starobogatov (1995), *Cambaroides wladiostokiensis* lives in Kumarovian Province (i.e., river basins discharging into the Sea of Japan from the Cape Povorotny down south to 38°N near Sokch'o; see Starobogatov, 1995). This area corresponds to the localities D (Ussuriysk, Russia), E (Hoeryong, North Korea), and I (Yanji, China) (Fig. 1). But morphology of specimens from I, E, and D do not agree with that of *C. wladiostokiensis* indicated by Starobogatov (1995).



**Fig. 4.** Values of length/width of rostrum and of telson in the present study. Starobogatov (1995) indicated the values of RL/RW for *Cambaroides wladiostokiensis* (abbreviated as *C. w.*) (oblique line bar), *C. dauricus* (*C. d.*) (solid bar), and *C. koshewnikowi* (*C. k.*) (solid bar) to be 1.0, 1.2-1.3, and 1.2-1.3, respectively, and the value of TL/TW for *C. w.* as 0.5 approximately (dotted line). Data from Bal'zina (B) and Harbin (H) are omitted.

In his key, Starobogatov (1995) provided two morphometric values for *C. wladiostokiensis* (RL/RW=1.0, TL/TW=0.5), *C. dauricus* (RL/RW=1.2-1.3), and *C. koshewnikowi* (RL/RW=1.2-1.3). But the values from all of our sampling localities vary, overlap, and most samples don't agree with the values of *C. wladiostokiensis*, *C. dauricus*, or *C. koshewnikowi* given by him (Fig. 4).

Morphology of male first pleopod is considered as an important taxonomic character for *Cambaroides* (Hobbs, 1974; Fitzpatrick, 1995) and it shows a simple secondary sex character which is only Form I (Kawai and Saito, 2001). It was reported that the adult male pleopods are different between any two species of *Cambaroides* (Hart, 1953), and the most striking feature being the morphology of apical robes of the pleopod (Okada, 1933; Fitzpatrick, 1995). From our crayfish samples, two types of the apical robe shapes are found. The first type comprises the samples from the localities B, C, D, F, H, I, and J and the second from C' and G (Fig. 5). The distolateral margin of the apex in the former type is slightly swollen and two large tubercles are suited at the mediocaudal margin, while the identical part of the latter is markedly swollen but only one small tubercle is present at the mediocaudal margin. The former highly resembles to that of *C. dauricus*, and the latter is the same with *C. schrenckii* (see Kessler, 1876; Faxon, 1885). Starobogatov (1995) provided only insufficient notes, sketch, and key in association with the establishment of his new taxon, and any more information is unavailable to date. The taxonomic validity of Starobogatov's opinion is dubious either by adjusted distribution, his key, or the character of

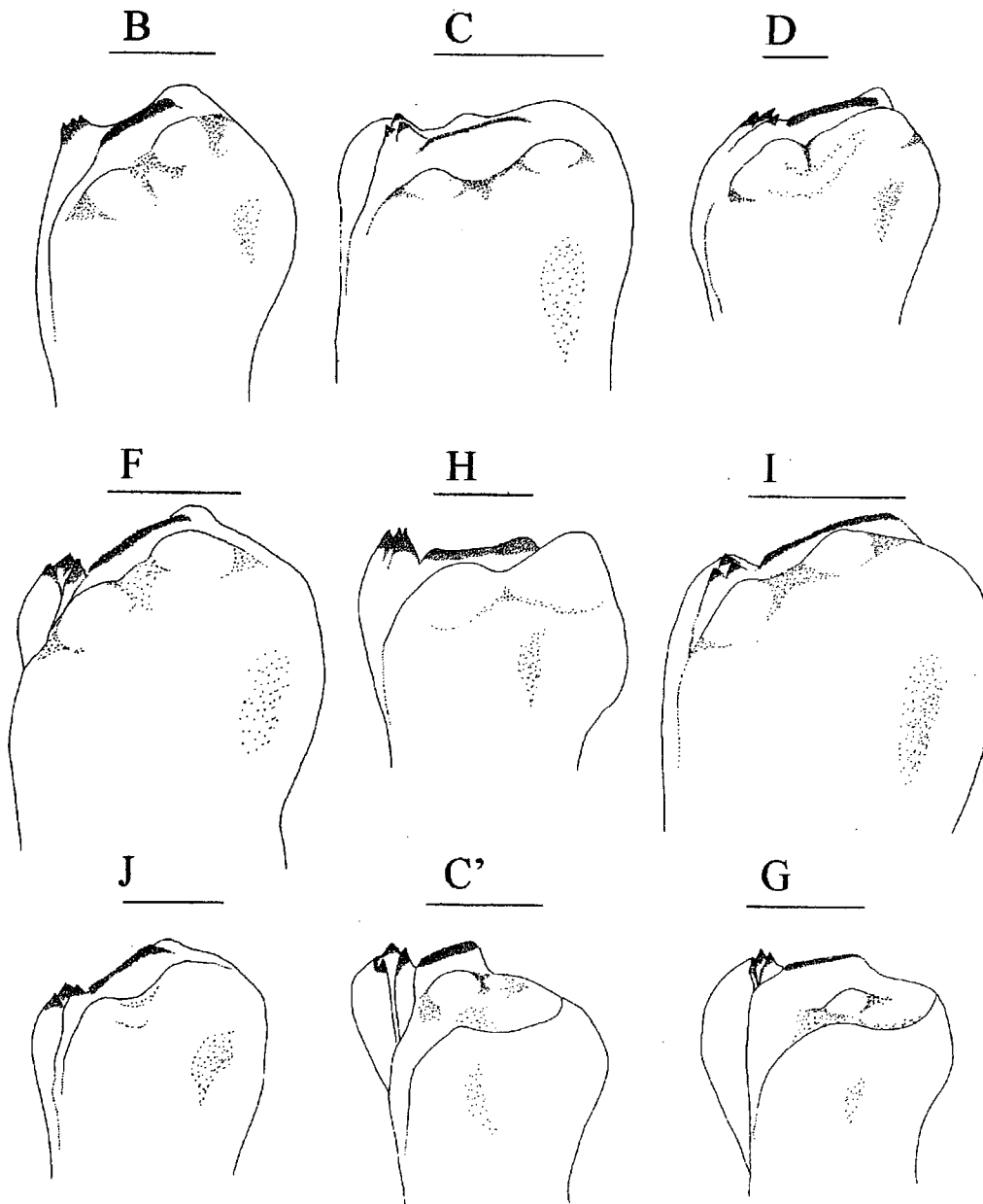


Fig. 5. Male first pleopod of one specimen from each locality. B (Bal'zina, Russia), C (Khabarovsk, Russia), D (Ussuriysk, Russia), E (Hoeryong, North Korea), F (Yalu River, North Korea), H (Harbin, China), I (Yanji, China), J (Fusong, China), C' (Khabarovsk, Russia), G (Tangyuan, China). Data from Onon River (A) was omitted. Line=1 mm.

the apical robe of male fist pleopod. As such we could not accept Starovogotov's opinion that three (*C. d. wladivostokiensis*, *C. d. dauricus*, and *C. d. koshevníkowi*) and two (*C. s. sachalinensis* and *C. s. schrenckii*) subspecies were elevated to full species by Birstein and Winogradov (1934).

Fitzpatrick (1995) found intra-specific variation of morphology in rostrum and pleuron as well as some other morphometric characters among the *Cambaroides* members sampled from different localities. In the present

study the morphology of rostrum, pleuron, and telson also appears to be different within the *C. dauricus* group (localities A, B, C, D, E, F, H, and I) and as well as within the *C. schrenckii* group (localities C' and G) (Table 2). Indeed it indicates morphological variation exists geographically. However, geographical races are not completely defined in the present study due to widely scattered sample localities and small sample sizes. And in the present study we did not examine specimens from Sakhalin, lower part of Amur according to the

biogeography indicated by Starobogatov (1995). Thus, we assume that there is either a geographical cline of morphological variation within the same taxon, or subspecies as suggested by Birstein and Winogradov (1934). Far-East Asian crayfish seems to leave several taxonomic questions unanswered. It is still necessary to study many other populations of the *Cambaroides* members, which are more widely distributed in Mongolia, Russia, China, North Korea, South Korea, and Japan.

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