

Female heterogamety and extraordinary low chromosome number in *Rana paramacrodon* (Amphibia: Ranidae)

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ABSTRACT The karyotypes of a male and two female specimens of *Rana paramacrodon* from Singapore were examined. The diploid number of $2N=20$ is the lowest known for the genus *Rana*. All the chromosomes were biarmed. The female frog was heterogametic (with ZW sex chromosomes), while the male was homogametic (ZZ). Autosome pair no. 1 was distinctly longer than the rest. The smallest autosome pair was also distinctive in size, morphology and the presence of a secondary constriction on the long arm.

ABSTRAK Kariotip *Rana paramacrodon* telah dikaji atas seekor katak jantan dan dua ekor katak betina dari Singapura. Nombor diploid dengan $2N=20$ adalah yang paling rendah bagi genus *Rana*. Setiap kromosom mempunyai dua lengan. Katak betina adalah heterogametik (dengan kromosom seks ZW), manakala katak jantan adalah homogametik (ZZ). Panjang pasangan autosom no. 1 berbeza dengan nyatanya daripada kromosom-kromosom yang lain. Pasangan autosom terkecil adalah juga distinktif dalam saiz, morfologi dan kewujudan cerutan sekunder pada lengan panjang.

(karyotype, female heterogamety, *Rana paramacrodon*, Amphibia, Anura)

INTRODUCTION

Rana paramacrodon was first described from Sabah and Sarawak, Malaysia [1]. Since then it has been recorded from Peninsular Malaysia [2] and Singapore [3]. It is principally a swamp-forest dweller.

Apart from morphological studies, locality records and ecological observations [1, 2, 3], there is little information on the biology of *R. paramacrodon*. We report here the chromosome number and the sex-determination system in this swamp-forest frog.

MATERIALS AND METHODS

One male and two female *R. paramacrodon* were collected from the Nee Soon swamp-forest, Singapore, in May 1991. These specimens were sacrificed for chromosome studies. Chromosome spreads were prepared from bone marrow cells, and in the case of the male specimen also from testicular tissues [4, 5].

RESULTS

All the three frogs possessed a diploid number of $2N=20$, consisting only biarmed chromosomes. The karyotype of the female frogs contained a heteromorphic pair (Fig. 1), while that of the male frog consisted of only homomorphic pairs as was also evidenced in meiosis (Fig. 2). This heteromorphic pair comprised the Z and W chromosomes.

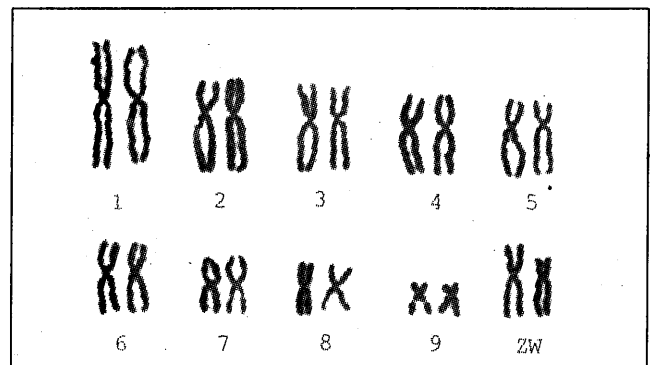


Figure 1. Karyotype of a female *Rana paramacrodon*. Note the presence of a secondary constriction on the long arm of the smallest autosome.

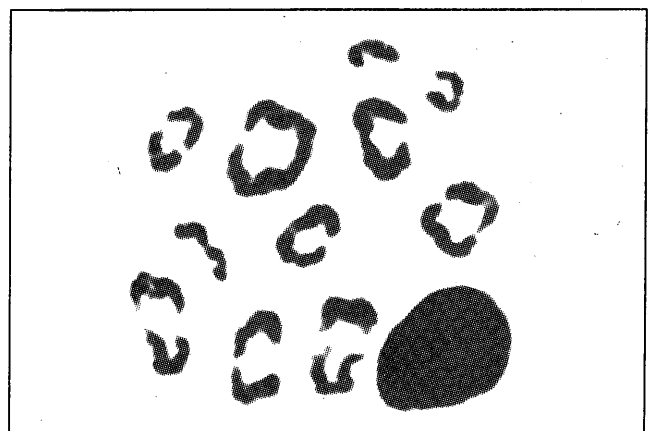


Figure 2. Meiotic metaphase-I of a male *Rana paramacrodon*.

Table 1. Karyotype of *Rana paramacrodon*. Chromosomes are grouped according to size.

Group	Chromosome Pair	Centromeric Position
A	1	metacentric
B	2	metacentric
	3	metacentric
	4	metacentric
	5	submetacentric
	6	metacentric
C	Z	metacentric
	W	submetacentric
	7	metacentric
D	8	metacentric
	9	submetacentric

The chromosomes could be arranged into four more or less distinct groups according to size (Table 1, Fig. 1). Autosome pair no. 1 was distinctly longer than the rest. Group B contained five pairs of autosomes and the Z chromosome. Autosome pair no. 5 was submetacentric, while the other pairs were metacentric. The metacentric Z chromosome was probably the shortest in the group. Group C contained the W chromosome and autosome pairs 7 and 8. The W chromosome was distinctive, with a submedian centromere. Both autosome pairs 7 and 8 were metacentric. Group D was represented by a single pair of autosomes, the smallest in the complement. It was submetacentric and characterized by the presence of a secondary constriction (NOR) on the long arm.

DISCUSSION

Most of the species in the genus *Rana* have a diploid chromosome number of $2N=26$. The lowest number previously reported has been $2N=24$ [for review, see 6].

The finding (first discovered in May 1991, and communicated to several scientists working on South-east Asian amphibians) of $2N=20$ for *Rana paramacrodon* is noteworthy. Three members (*R. blythi*, *R. macrodon* and *R. magna*) of the *Rana grunniens* group, to which *R. paramacrodon* belongs, had been reported to possess $2N=24$ [7,8,9]. Another member, *R. malesiana* also possesses $2N=24$ (H.S. Yong, unpublished data). It is evident that *R. paramacrodon* stands out karyotypically from the other members of the group.

In addition to low chromosome number, *R. paramacrodon* has a ZW/ZZ sex-determining mechanism, the female being the heterogametic sex. This ZW/

ZZ system has been reported in three other ranid frogs – *Pyxicephalus adspersus*, *Rana cyanophlyctis* and *Rana tigerina* [10,11,12]. There are also ranid species with the XX/XY mechanism, meaning male heterogamety [6].

This and earlier studies [8] indicate that the amphibians of Malaysia offer great opportunities for karyological, evolutionary and other biological studies.

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