CHROMOSOMES OF TWO PODAGRION SPECIES (HYMENOPTERA, CHALCIDOIDEA, TORYMIDAE) AND THE EVOLUTION OF HIGH CHROMOSOME NUMBERS IN CHALCIDOIDEA

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Abstract: Karyotypes of two species of *Podagrion* are studied for the first time. Chromosome numbers with n = 10 found in this species are the highest records for the family Torymidae. This unique karyotypes are supposed to be derived by centric fission from the ancestral karyotype of the family with n = 6. This finding allows the analysis of some aspects of karyotype evolution in Chalcidoidea, a superfamily of Hymenoptera characterized by low chromosome numbers (usually n = 5 - 6).

INTRODUCTION

Members of *Podagrion* are specialized parasitoids of Mantodea ootheca, with five described species in Europe. Four species are characteristic for the Mediterranean Basin and only one species is distributed northerly, up to Poland (Delvare 2005). No cytogenetical data are known for this genus and the chromosomes were studied only in 15 Torymidae species (see the review of Gokhman & Quicke 1995 and recently published new data on two species by Gokhman 2005).

MATERIAL AND METHODS

As live specimens are used for karyological studies, only the two species found in Romania where analyzed. Females of *Podagrion pachymerum* (Walker, 1833) were reared from a parasitized *Mantis religiosa* (Linnaeus) ootheca collected at “Valea lui David” Natural Reservation, Iaşi, Romania in the autumn of 2005 (leg. Popescu I.). *Podagrion gibbum* (Bernard, 1938) was collected by the author from “Hagieni Forest” Natural Reservation, Mangalia, Romania on 27.V.2006, and the only surviving female was used in the study. The species were identified by the author using the recent revision of the genus by Delvare (2005); voucher specimens are preserved in author’s collection.

Chromosome preparations were obtained from the ovaries of adult females using the technique of Imai *et al.* (1988). Karyograms were constructed arranging homologue chromosomes by decreasing length and the nomenclature used for centromere position follows Levan et al. (1964) and Imai et al. (1977).

RESULTS AND DISCUSSIONS

Podagrion pachymerum (ten metaphasic plates and one diakinesis from seven females analyzed), n = 10, $2n$ = 20 (4M + 4SM + 4ST + 8A). The chromosomes of the first pair are obviously biarmed, metacentric. The rest of the chromosomes in the karyotype are much smaller (those of the 2nd pair about half the size of the chromosomes in the first pair) and gradually decreasing in length. Chromosomes 2 and 7 are submetacentric, 3 are metacentric, 4 and 5 subtelocentric, 6, 8, 9, and 10 apparently acrocentric (Fig. 1 b).

The meiotic chromosomes at diakinesis and the meiotic karyogram are shown in Fig. 1 c, d. Ten bivalents were observed, each of them bearing a single chiasmata.

Podagrion gibbum (two metaphasic plates and one prometaphase from one female analyzed). $2n$ = 20 (4M + 16 ST). The karyotype is similar to that of the previous species, but all the chromosomes except metacentric pairs 1 and 3 are subtelocentric (Fig. 1 a).

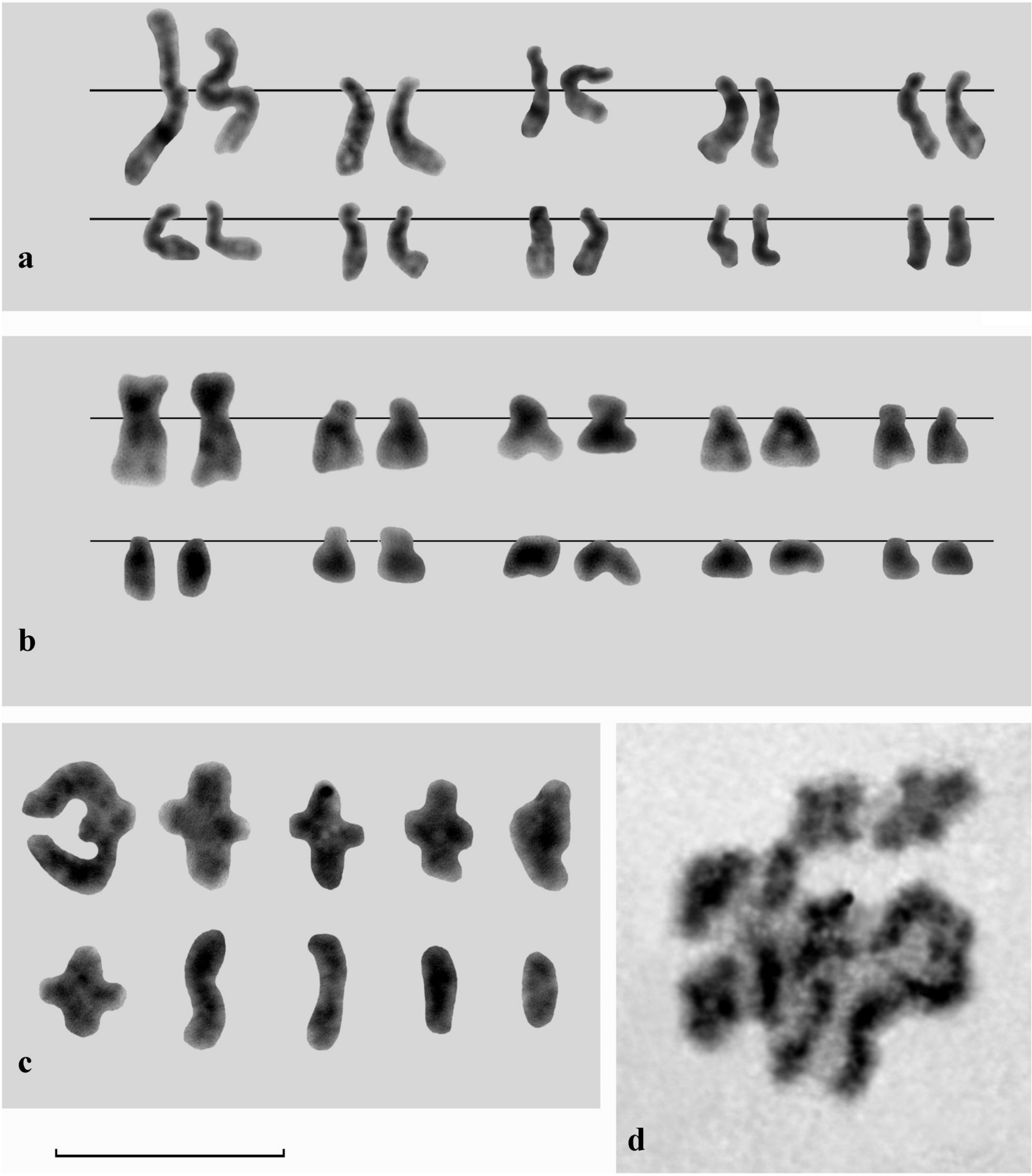

Figure 1. Chromosomes of *Podagrion* spp.: a – mitotic karyogram of *Podagrion gibbum*; b – mitotic karyogram of *P. pachymerum*; c - meiotic karyogram in *P. pachymerum*; d – diakinesis in *P. pachymerum*. Scale bar 10 µm.

The karyotype of Torymidae was shown to have a small number of chromosomes with n = 4 – 6 (Gokhman & Quicke 1995, Gokhman 2005) the karyotype with n = 10 discovered in *Podagrion* being the highest chromosome number record for the family. Gokhman (2004, 2005) hypothesized that a karyotype with n = 6 (five long, biarmed chromosomes and a short subtelo- or acrocentric) is the ground plan state for the family. As *Podagrion* is a derived Torymidae (Grissel 1995), the most plausible explanation of the unique karyotype in this genus is that it evolved by centric fission of 4 of the five biarmed chromosomes in the supposed ancestral karyotype followed by subsequent modification of the resulting acrocentric chromosomes. The predominance of acrocentric and subtelocentric chromosomes in the karyotype of the two studied species gives further support to this hypothesis.

The emergence of karyotypes with high chromosomes numbers in groups with small chromosome numbers (as in Torymidae) can shade some light on karyotype evolution in Chalcidoidea. The most frequent chromosome numbers in chalcidoid wasps are n = 5 – 6, but higher chromosome numbers (n = 8 – 12) were found in Mymaridae, Eurytomidae, some Aphelinidae and Encyrtidae. By outgroup comparison this high chromosome numbers are interpreted as a plesiomorphic character state (Gokhman & Quicke 1995, Gokhman 2000). If for Mymaridae and Eurytomidae this is very convincing, as Mymaridae are possible sister group to other Chalcidoidea (Gibson 1986, Gibson, Heraty & Woolley 1999) and Eurytomidae are a basal family (Zerova 1995) of the "pteromalid" lineage, this character state is more difficult to interpret in Encyrtidae. Encyrtidae could form a clade with Tanaostigmatidae and Eupelmidae or at least with Tanaostigmatidae, Neanastatinae and Calosotinae based at least on possible autapomorphies in mesonotum structure (Gibson 1989). As Eupelmidae have a small chromosome number with n = 5 (Gokhman & Quicke 1995, Gokhman 2002), the karyotype with high chromosome numbers in Encyrtidae could be in fact secondary derived by centric fission. All Encyrtidae species studied to date (Gokhman & Quicke 1995, Gokhman 2004, Guerrieri & Noyes 2005, Fusu in preparation) have high chromosome numbers and the species that conserved the ancestral karyotype with lower chromosome number probably went extinct during the evolution of the family or are yet to be discovered. Unfortunately there are no karyological data on Tanaostigmatidae, sister group of Encyrtidae (Gibson 1989) to sustain or reject this hypothesis.

What factors could lead to the secondary apparition of karyotypes with high chromosome numbers in Chalcidoidea? The vast majority of Chalcidoidea has a small chromosome number and consequently a reduced level of recombination. As chalcidoids are small insects with reduced dispersal capabilities and inbreeding due to sib mating is a frequent phenomenon (Askew 1971), this is thought not to be so deleterious (Gokhman & Quicke 1995). Imai *et al.* (1999) find a positive correlation between the haploid chromosome number and chiasma frequency per cell, so a possible explanation for the secondary evolution of a karyotype with high chromosome number is the selective pressure to attain a higher level of genetic diversity.

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