Karyological Studies of *Arvicanthis niloticus* (Rodentia: Murinae) in Egypt

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Abstract: *The karyotype and C-banding pattern of the unstriped grass rat,* Arvicanthis niloticus, *from four localities in Egypt are presented. All karyotyped individuals have, as a rule, the same diploid number of 2n = 62 and autosomal fundamental number of aFN = 62. All chromosomes have a large centromeric block of fairly uniform size. An additional interstitial or telomeric small C-band is scored in some chromosomes. However, frequent polymorphism in the morphology and heterochromatin of both the homologous chromosomes of the pair no. 1 and the X chromosome is scored in some individuals from four localities and led to an aFN = 63. Accordingly, four forms or cytotypes, namely ANI-1^a, ANI-1^b, ANI-1^c and ANI-1^d, are recognized based on this variation, which may indicate the occurrence of either addition or deletion of a heterochromatic segment as a result of pericentric inversions. Of these four forms, the ANI-1^a is considered ancestral for* A. niloticus *in Egypt and is closely similar to that of the Ethiopian* A. dembeensis, *regardless the contradiction concerned with the morphology of the X chromosome, while the karyotypes of the other forms are synapomorphy of the form ANI-1^a. These forms also showed a relative resemblance to those of the Ethiopian* A. abyssinicus *and* A. blicki. *Therefore, it is concluded that the genus* Arvicanthis *could be represented by an Egyptian-Ethiopian radiation* (A. niloticus, 'A. dembeensis', A. abyssinicus *and* A. blicki) *and by a Central-Western African one including the karyotypes described as* 'A. centralis' *and* 'A. solatus'. *Moreover,* A. niloticus *should no longer be regarded as a single species but as a cluster of several proper species.*

Key words: *Arvicanthis niloticus*, Murinae, Rodentia, karyotype, C-heterochromatin.

INTRODUCTION

The unstriped grass rat or Nile rat of the genus *Arvicanthis* has a widespread distribution throughout the African savannas south of the Sahara and extending along the Nile Valley to the Mediterranean sea and its taxonomy has long been the subject to repeated discussions. The difficulties of its taxonomy, particularly the species composition and their distribution limits, result primarily from the combination of large inter-individual variability in body measurements and pelage coloration and relatively low differentiation amongst population. On the basis of morphological variations, Allen (1939) recognized 37 subspecies among the following six species: *Arvicanthis niloticus, A. lacernatus, A. tenebrosus, A. ochropus, A. abyssinicus* and *A. somalicus*. However, Ellerman (1941) considered *A. tenebrosus* as a subspecies of *A. abyssinicus* and *A. ochropus* as a synonym of *A. niloticus*. Later on, a specific status is conferred to one subspecies of *A. niloticus*, which became *A. blicki* by Dorst (1972). Nevertheless, Misonne (1974) lumped all of the previously described subspecies into one species *A. niloticus*. Subsequently, Yalden *et al.* (1976) distinguished these subspecies as fairly five species: *A. niloticus, A. abyssinicus, A. blicki, A. dembeensis* and *A. somalicus*. Corbet and Hill (1980) counted also five species, but they conferred a specific rank to a subspecies of *A. niloticus, A. testicularis,* and rejected the status of species for *A. dembeensis*. Moreover, Honacki *et al.* (1982) confirmed Misonne's (1974) assumption that the genus *Arvicanthis* is monotypic with only one subspecies *A. niloticus*. Furthermore, Rousseau (1982) recognized four species: *A. niloticus, A. abyssinicus, A. blicki* and *A. somalicus*, but Nowak and Paradiso (1983) added to them a fifth species *A. dembeensis* as previously assumed by Yalden *et al.* (1976). Further, Musser and Carleton (1993) recognized five species, namely *A. abyssinicus, A. blicki, A. neumanni, A. nairobae* and *A. niloticus*, where the first three species are distinct and easily recognizable, while the definition and diagnosis of the other two species are still unsatisfactory.

Karyological data, on the other hand, are not less confusing where several diploid numbers (2n) 46 (Capanna *et al.*, 1985), 56 (Matthey, 1965), 58 (Volobouev *et al.*, 1987, 2002) and 62 (Viégas-Péquignot *et al.*, 1983; Volobouev *et al.*, 1988, 2002; Capanna *et al.*, 1996) are described for *A. niloticus*, 62 for *A. abyssinicus* (Matthey, 1959; Orlov *et al.*, 1992; Civitelli *et al.*, 1995; Capanna *et al.*, 1996; Corti *et al.*, 1996), 62 for *A. nairobae* and 53-54 for *A. neumanni* (Castiglia *et al.*, 2003), 48 for *A. blicki* (Corti *et al.*, 1995, 1996) and 62 for *A. dembeensis* (Capanna *et al.*, 1996; Corti *et al.*, 1996).

In Africa, the very slight external morphological differentiation displayed by *Arvicanthis* samples in western and central regions encouraged most authors to consider them as belonging to the sole species *A. niloticus*. However, biochemical (Kaminski *et al.*, 1984, 1987; Capanna *et al.*, 1996; Capula *et al.*, 1997), geometrical morphometric (Fadda, 1998; Corti *et al.*, 1996; Ducroz *et al.*, 1997), karyotypic (Volobouev *et al.*, 1987, 1988; Capanna *et al.*, 1996; Corti *et al.*, 1996; Ducroz *et al.*, 1997 and molecular (Ducroz *et al.*, 1997,

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1998) data contradicted such taxonomic arrangement. This is because the chromosome banding studies, for example, have revealed the existence of four chromosomal forms labeled as ANI-1, ANI-2, ANI-3 and ANI-4 (Ducroz, 1998). The differences between these forms have been interpreted via laboratory crossbreeding experiments (Ducroz *et al.*, 1997) as a series of chromosomal arrangements resulting likely from reproductive isolation (Ducroz, 1998). Recently, Volobouev *et al.* (2002) supported the existence of these four karyotypic forms, or cytotypes, and provided a distinct geographic distribution limit for each species throughout western and central Africa. In addition, they proposed that the three western African species ANI-1, ANI-3 and ANI-4 could be renamed as *A. niloticus*, *A. ansorgei* and *A. rufinus*, respectively; however, the affinity and naming of ANI-2 is still uncertain whether it is *A. centralis* or *A. testicularis*. In Egypt, however, morphological (Fadda and Corti, 1998 and Fadda *et al* 2001), biochemical (Kaminski *et al.*, 1984), cytogenetic (Viégas-Péquignot *et al.*, 1983; Volobouev *et al.*, 1988) and molecular (Ducroz *et al.*, 1998, 2001) data revealed the occurrence of a single species ANI-1, *viz.*, *A. niloticus* which has been considered a geographic variant of the Ethiopian *A. dembeensis* (Yalden *et al.*, 1976; Volobouev *et al.*, 1988; Orlov *et al.*, 1992; Musser and Carleton, 1993; Corti *et al.*, 1996).

Despite these immense studies on the taxonomy of *Arvicanthis* along all ranges of its distribution, additional morphological, chromosomal and molecular investigations are necessary to understand the connection between this karyotypic diversity and to evaluate their distribution limits and support the previous suggestions of its taxonomy. In addition, previous chromosome data varied among authors in the ordering of chromosome pairs within karyotypes, hence making comparisons of the available data quite difficult. As a consequence, the extent of intraspecific chromosomal variation and interspecific karyological differences remained to be assessed. In this context, the necessity of a standardized chromosome nomenclature and the study of larger samples from more widespread geographical areas have become crucial. Moreover, the cytogenetic conclusions concerned with the occurrence of a single form ANI-1, or cytotype, of *A. niloticus* in Egypt are primarily based, in many cases, on a single locality samples. Hence, it was found useful and crucial to carry out a detailed survey study of *Arvicanthis* populations in Egypt, with the major objectives of 1) scoring of all possible forms of this species throughout all parts of its distribution in Egypt, 2) identifying and characterizing the karyotypes of these forms, 3) assessing the karyotype evolution among these forms by examining the C-banding pattern, and 4) comparing the present data with that available in the literatures on *A. niloticus* from Egypt and other countries and particularly on the Ethiopian species in an attempt to clarify their cytogenetic relationship

MATERIALS AND METHODS

Adult individuals of the grass rat *Arvicanthis niloticus* (Lesson 1842) were collected from the following four localities in Egypt: Al-Sharqiya, Al-Minufiya, El-Faiyum and El-Minia. The collecting sites and the corresponding samples sizes are indicated in Fig. 1

The animals were intraperitoneally injected with 0.05% colchicine solution (0.01 ml/g body weight) and one hour later killed with chloroform. Mitotic chromosomes spread from the femoral bone marrow cells were prepared by the flame drying technique using the method of Yosida (1973), with a slight modification (Shahin and Ata, 2001).

About 100 metaphase spreads from each animal in the different population localities were examined and the karyotype from each population was determined based on five to ten well-spread metaphase cells. Chromosomes were measured under Olympus BX 51 microscope using the soft imaging system (SIS) analysis program (Version 3.0) edited in 1999 by Soft Imaging System GmbH, Germany, and classified according to the system proposed by Green and Sessions (1991) and as described by Shahin and Ata (2001). C-bands were attained by using the standard protocol of Sumner (1972), with major modification (Shahin and Ata, 2004). About 100 to 200 metaphase plates from both males and females of each individual in each locality were examined and good spreads (about 20-30) from each locality were scored and photographed using Olympus BX 51 microscope with a C-4040 zoom digital camera. The C-banding karyotype was determined and prepared as in the conventional preparation technique.

RESULTS

Karyotype description

Basically, the karyotype of *A. niloticus* (primarily designated as ANI-1) from the four localities surveyed in this study consists of a diploid number (2n) of 62 chromosomes and an autosomal Fundamental Number (aFN) of 62. Of the 62 chromosomes, the X chromosome appears here as a large subtelocentric depending upon the arm ratio values; however, it is previously described by many authors as a large submetacentric, while the Y chromosome is a medium-sized metacentric. The remaining 60 autosomes are variable-sized acrocentrics (telocentrics), except the pair no. 25 which is metacentrics, and, therefore, they are arranged in a graded series according to their lengths (Fig. 2a). Nevertheless, frequent variation in the morphology of the homologous chromosomes of the pair no. 1 and the X chromosome is scored among individuals of some localities (Figs 2b and 3, Table 1). Consequently, as the result of this heterozygosity and of the relative sympatry between some populations, particularly between El-Faiyum and El-Minia localities, four forms or cytotypes could be recognized within the karyotype of the 60 individuals of *A. niloticus* examined from the four localities (Figs. 2 and 3, Table 1). A detailed description of the four karyotypic forms is as the following:

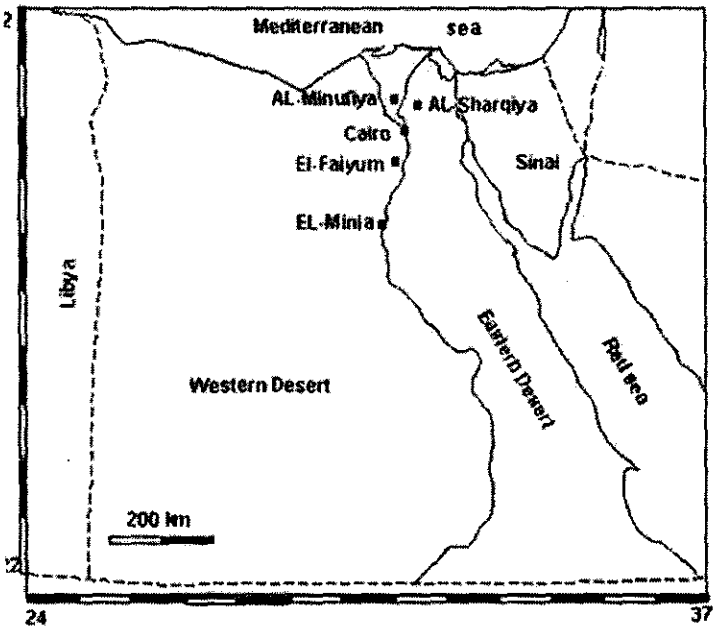

Figure 1. A map showing the geographic localities from which individuals of *Arvicanthis niloticus* are collected. The localities and samples sizes are: Al-Sharqiya 23, Al-Minufiya 9, El-Faiyum 9 and El-Mini a 19.

ANI-1[a]: This type represents the basic karyotype of *A. niloticus* and it is recorded in a total of 39 individuals (15 ♂ and 24 ♀) from the 60 individuals collected from the four localities: Al-Sharqiya (4 ♂ and 12 ♀), Al-Minufiya (3 ♂ and 4 ♀), Al-Fayiyum (4 ♂) and El-Minia (4 ♂ and 8 ♀). The karyotype consists of 2n = 62 chromosomes and aFN = 62. All the autosomes, including the pair no. 1, are acrocentrics except the pair no. 25 which is metacentric. The X chromosome is a large subtelocentric, while the Y chromosome is a medium-sized metacentric (Fig. 2a, Table 1).

ANI-1[b]: This karyotype is characterized by the presence of heteromorphism in the homologous chromosomes of the pair no. 1 and monomorphism in the X chromosome. Therefore, it is nearly identical to that of ANI-1[a], i.e. it has a 2n = 62 and aFN = 62, except that the homologous chromosomes of the pair no 1 are heteromorphic, one chromosome is acrocentric, while the other is subtelocentric, thus resulting in an aFN = 63. This karyotype is not scored in animals from El-Faiyum locality; however, it is recognized in only 13 animals (3 ♂ and 10 ♀) of the 51 animals examined from Al-Sharqiya (2 ♂ and 5 ♀), Al-Minufiya (2 ♀) and El-Minia (1 ♂ and 3 ♀) localities (Fig. 2b, Table 1).

ANI-1[c]: This karyotype includes individuals, which displayed heteromorphism in the X chromosome, while the homologous chromosomes of the pair no. 1 are monomorphic. Likewise ANI-1[a], the chromosome complement of this karyotype, consists of 2n = 62 chromosomes and aFN = 62 in individuals from all localities. The heterogeneity in the X chromosome, which is related to relative variation in length of the short arms, is scored in only two females from each of El-Faiyum and El-Minia localities where they are sorted as submetacentric (Fig. 3a, Table 1).

ANI-1[d]: This karyotype comprises animals, which showed heteromorphism in both of the chromosomes of the pair no. 1 and the X chromosome. Accordingly, this form consists also of 2n = 62 chromosomes, but the aFN is either 63, as found in only three animals (1 ♂ and 2 ♀) from El-Faiyum and (1 ♂) from El-Minia where one chromosome of the pair no. 1 is acrocentric, while its homologue is subtelocentric (Fig. 3b, Table 1), or 62 as appeared in the remaining animals from the four localities. The morphology of the X chromosome is closely similar to that found in the karyotype of ANI-1[c].

C-heterochromatin

As a rule, all autosomes of *A. niloticus* from the four localities surveyed in this study have a large centromeric block of fairly uniform size (Figs. 2 and 3). However, in the subtelocentric chromosome of the pair no. 1, the short arm is not entirely heterochromatic. This feature is detected in 13 animals: four females from Al-Sharqiya, two females from Al-Minufiya, five males from El-Minia and a single male and female from El-Faiyum (Figs. 2b and 3b). In addition, some autosomal pairs of both males and females from all localities show either interstitial (pair no. 1) or telomeric (pairs nos. 2, 4, 5, 6, 10, 11, 14, 15 and 20) light to dark C-band, which likely indicate the location of the nucleolus organizer regions (Fig. 3). Moreover, the short arms of

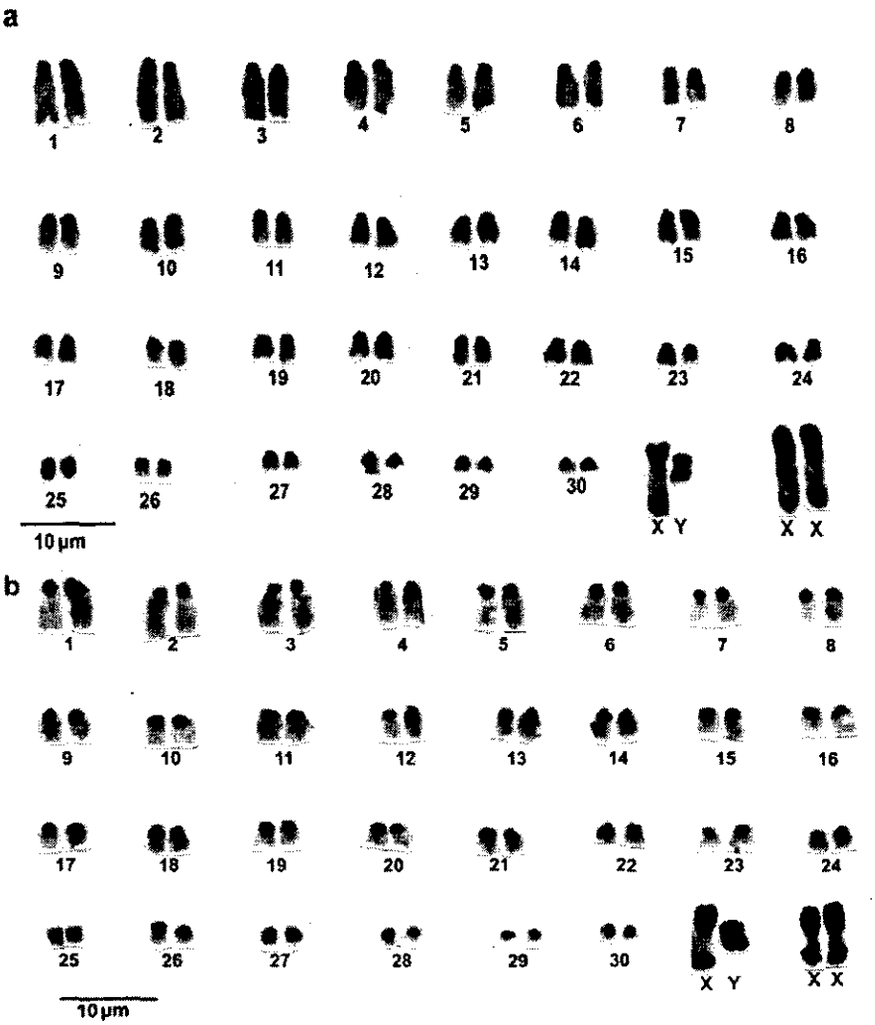

Figure 2. Karyotype and C-banding pattern of males of *A. niloticus*. **(a)** Cytotype ANI-1[a] and **(b)** Cytotype ANI-1[b]. In addition, the female XX chromosomes are shown.

the X chromosome are completely stained intensively in the pericentromeric region, while the long arms show a relatively small, less stained, interstitial C-band located near the distal region. The Y chromosome is stained more intensively and thus it is almost entirely heterochromatic. Nonetheless, a heteromorphic feature related to variations in the amount of C-heterochromatin in the short arms of the X chromosome is recorded in three animals (1 ♂ and 2 ♀) from each of El-Faiyum and El-Minia localities due to relative differences in the length of short arms (Fig. 3).

DISCUSSION

As far as, *A. niloticus*, labeled ANI-1 by Volobouev *et al.* (1988), is known to exhibit a discrete chromosomal variability, with diploid numbers varying from 2n = 44 to 2n = 62. Within this range of diploid numbers, five to six cytotypes are recognized: two of which with 2n = 62 exhibited additional chromosome polymorphism and three cytotypes are described as cryptic species with 2n = 58, 56 and 44 (Matthey, 1965; Volobouev *et al.*, 1987, 1988; Capanna and Civitelli, 1988). Moreover, Ducroz *et al.* (1997) pointed out that the cytotype ANI-1, with 2n = 62, corresponds to *A. niloticus sensu stricto* (Nile Valley and northern Sahelian territory). Furthermore, the Egyptian *A. noliticus* has been proven to be similar to *A. niloticus* populations from East of Senegal (Volobouev *et al.*, 1988; Corti *et al.*, 1996) as well as it has been considered a geographic variant of the Ethiopian *A. dembeensis* (Viégas-Péquignot *et al.*, 1983; Orlov *et al.*, 1992; Musser and Carleton, 1993; Capanna *et al.*, 1996; Corti *et al.*, 1996). This relationship is suggested by the high similarity of their karyotypes which consist of 2n = 62 and aFN = 62 (Orlov *et al.*, 1992; Capanna *et al.*, 1996; Corti *et al.*, 1996) and named ANI-1 by Volobouev *et al.* (1988). Nevertheless, it has been

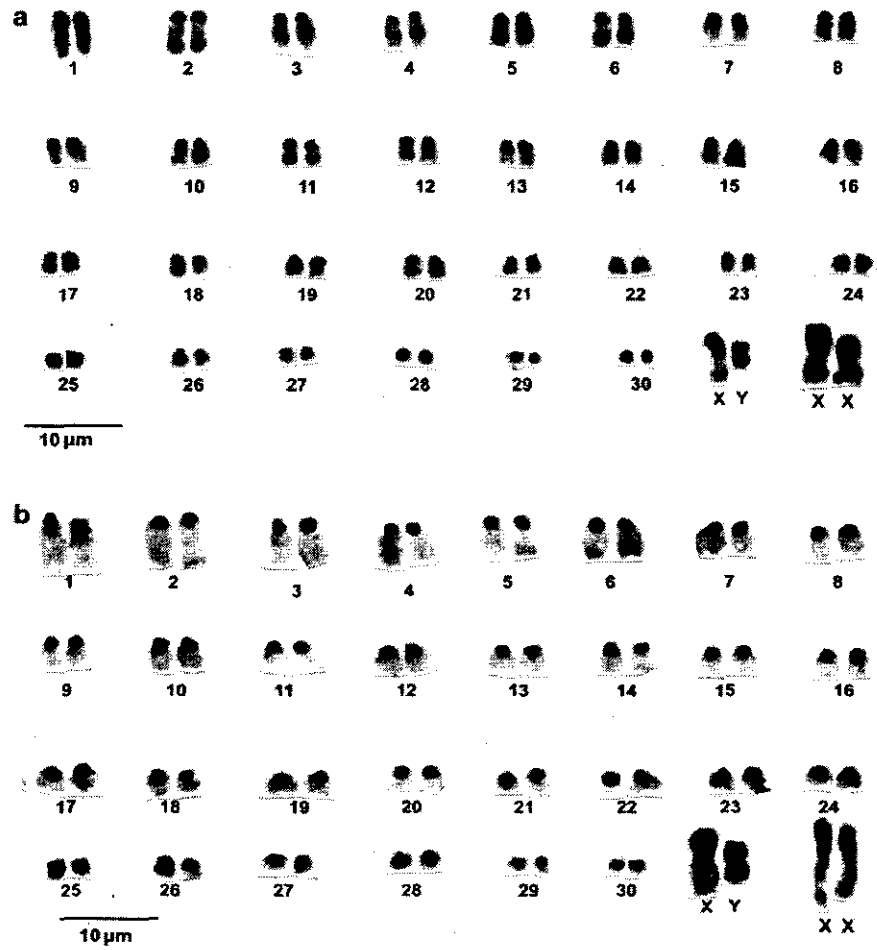

Figure 3. Karyotype and C-banding pattern of males of *A. niloticus*. **(a)** Cytotype ANI-1[c] and **(b)** Cytotype ANI-1[d]. In addition, the female XX chromosomes are shown.

established that the Egyptian form, ANI-1, differs from the other forms ANI-2 and ANI-3 from Burkina-Faso, Mali and Central African Republic by limited chromosomal rearrangements, mostly by a pericentric inversion and likely by a reciprocal translocation (Volobouev *et al.*, 1988).

Concerning the karyotypes of the four forms scored here in this study, it is evident that the cytotype ANI-1[a] is closely consistent in its configuration and C-heterochromatin with that of the Ethiopian lowland *A. dembeensis* (Capanna *et al.*, 1996; Corti *et al.*, 1996), without regard to variation in the nomenclature of the X chromosome. On the basis of the arm ratio values, the morphology of the X chromosome appeared herein as well as in the previous studies by Volobouev *et al.* (1987, 1988) and Viégas-Péquignot *et al.* (1983) as large subtelocentric; however, the latter authors have sorted it as submetacentric. Similarly, the X chromosome of the Ethiopian *A. dembeensis* has been designated by Capanna *et al.* (1996) and Corti *et al.* (1996) as large submetacentric, although it appears in their cited photographs as subtelocentric. In addition, the form ANI-1[a] is quite similar to the cytotypes ANI-1 recognized by Volobouev *et al.* (1988) from Cairo and Senegal and ANI-1a described by Volobouev *et al.* (2002) from Niger, Chad and Mali, except the variation concerned with the occurrence of telomeric C-band in the pairs nos. 4, 10, 11, 14, 15 and 20 scored in this study. On the contrary, there are quite variations between the four forms suggested here in this study and the other *A. niloticus* forms such as ANI-2 from Central African Republic and ANI-3 from Burkina Faso and Mali (Volobouev *et al.*, 1988) as well as ANI-1b from Mali, Senegal, Burkina Faso and Mauritania (Volobouev *et al.*, 2002) and *A. niloticus* from Benin (Civitelli *et al.*, 1995). These variations have been attributed to numerous chromosomal rearrangements, most of which are due to pericentric inversions and heterochromatin additions/deletions and likely to reciprocal and Robertsonian translocations (Corti *et al.*, 1996; Volobouev *et al.*, 1988, 2002).

Generally, the variation in of C-heterochromatin between a pair of homologue chromosomes or among chromosomes of the same karyotype or even among karyotypes of the closely related species has been attributed by many authors to transformation of heterochromatin into euchromatin or *vice versa* or to deletion or duplication of heterochromatic segments (Shahin and Ata, 2004).

Comparison of the chromosomes morphology and C-banded karyotypes of the recognized four forms showed that all autosomes are identical, except that the subtelocentric chromosome of the pair no. 1 categorized in ANI-1^{b} and ANI-1^{d} and which acquired a short heterochromatic arm is involved in a deletion of this arm as well as a pericentric inversion in ANI-1^{a}. In addition, the subtelocentric chromosome of the X chromosome in ANI-1^{a} and ANI-1^{b}, particularly in females from El-Minia locality, is involved also in an addition of segment as well as a further pericentric inversion in ANI-1^{c} and ANI-1^{d} and thus acquired a heterochromatic short arm. However, the acquisition of a relatively short heterochromatic short arm is due to the delation of a heterochromatic block to the distal part of the short arm as a result of a pericentric inversion. Similar findings of polymorphism in the X chromosome (with metacentric, submetacentric and subtelocentric configuration) both in homozygous and heterozygous state have been found in the South of Benin for the cytotype ANI-3, without any apparent reduction in relative fertility of structural heterozygotes (Civitelli *et al.*, 1995). This heterozygosity observed among the four cytotypes in both of the homologues of the pair no. 1 and the X chromosome as well as the presence of a limited number of chromosomal rearrangements amongst these forms could likely be interpreted as crossbreeding resulting from reproductive association between these forms, but the postulation of such hypothesis needs further laboratory crossbreeding experiments.

As regards, the karyotype of the form ANI-1^{a} represents the ancestral karyotype of *A. niloticus* in Egypt, which has previously been described by many authors as ANI-1 from Cairo and *terra typica*, i.e. the Nile delta (Viégas-Péquignot *et al.*, 1983; Corti *et al.*, 1996; Volobouev *et al.*, 1987, 1988, 2002). This karyotype is apparently quite homologous to that of the Ethiopian *A. dembeensis* populations (Orlov *et al.*, 1992; Corti *et al.*, 1996), regardless the contradiction concerned with the morphology of the X chromosome. This similarity, however, could be due to convergence, as both species occur at low altitudes and are adapted to lowlands. On the other hand, the karyotypes of the other forms are synapomorphy, i.e. they are derived from the cytotype ANI-1^{a} and produced by limited chromosomal rearrangements, mostly by addition or deletion of chromosomal segments as a result of pericentric inversions. This conclusion is supported as well by G-banding analyses of which data are under preparation. Moreover, the heteromorphism observed in the shape and size of the X chromosome that can be either subtelocentric or submetacentric and also its heterochromatin content, particularly in the forms ANI-1^{b} and ANI-1^{d}, is similar to that found in the Ethiopian *A. abyssinicus* and *A. blicki* (Corti *et al.*, 1996). Furthermore, the subtelocentric chromosome of the pair no. 1 found in the forms ANI-1^{c} and ANI-1^{d} is homologous to the chromosome no. 4 in both *A. abyssinicus* and *A. blicki* (Corti *et al.*, 1996), with regardless of their differences in size.

As a consequence, it could be concluded that the Egyptian *A. niloticus* is just a geographic variant of the Ethiopian *A. dembeensis* as assumed by Viégas-Péquignot *et al.* (1983), Volobouev *et al.* (1988), Orlov *et al.* (1992) and Corti *et al.* (1996). This hypothesis supports also the inclusion of *A. dembeensis* in *A. niloticus* (Musser and Carleton, 1993) and contradicts the consideration of Yalden *et al.* (1976) and Corbet and Hill (1991) who classified *A. dembeensis* as a separate species. Moreover, it is apparent as suggested by Corti *et al.* (1996) that the genus *Arvicanthis* would be represented by an Egyptian-Ethiopian radiation (*A. niloticus* (synonym *A. dembeensis*), *A. abyssinicus* and *A. blicki*) and by a Central-Western African one (Volobouev *et al.*, 1987, 1988), including the karyotypes described by Civitelli *et al.* (1995), Grajon *et al.* (1992) and by Volobouev *et al.* (1988) as '*A. centralis*' and '*A. solatus*'.

Finally, as assumed by many authors on the basis of chromosomal data, the genus *Arvicanthis* is polytypic (see Volobouev *et al.*, 1988). This assumption, although it is proposed also by morphological data (Rousseau, 1982; Nowak and Paradiso, 1983), it contradicts the earlier opinion of Misonne (1974) and Honacki *et al.* (1982). Moreover, *A. niloticus*, as pointed out by Volobouev *et al.* (1988), should be regarded no longer as a single species but as a cluster of several proper species.

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Table 1. A summary of chromosomal characteristics of the four forms or cytotypes scored for *Arvicanthis niloticus* from the four localities surveyed in Egypt. Measurements are given in μm and data are presented as means ± (SE). Abbreviations: m = metacentric; sm = submetacentric; st = subtelocentric; t = telocentric (acrocentric).

Localities (Sample size)	Cytotypes															
	AN1-1[a]				AN1-1[b]				AN1-1[c]				AN1-1[d]			
	Pair no. 1		X chromosome		Pair no. 1		X chromosome		Pair no. 1		X chromosome		Pair no. 1		X chromosome	
	Arm ratio	Type	Arm ratio	Type	Arm ratio	Type	Arm ratio	Type	Arm ratio	Type	Arm ratio	Type	Arm ratio	Type	Arm ratio	Type
Al-Sharqiya (23)	0.00 ± (0.00)	t	2.18 ± (0.06) ♀	st	8.79 ± (1.15) ♀*	st	2.18 ± (0.64) ♀	st	0.00 ± (0.00)	t	-	-	-	-	-	-
	0.00 ± (0.00)	t	2.35 ± (0.16) ♂	st	0.00 ± (0.00) ♀*	t	2.35 ± (0.16) ♂	st								
Al-Minufiya (9)	0.00 ± (0.00)	t	2.22 ± (0.04) ♀	st	5.19 ± (0.42) ♀*	st	2.22 ± (0.04) ♀	st	0.00 ± (0.00)	t	-	-	-	-	-	-
	0.00 ± (0.00)	t	2.20 ± (0.46) ♂	st	0.00 ± (0.00) ♀*	t										
El-Faiyum (9)	0.00 ± (0.00)	t	2.50 ± (0.09) ♂	st	-	-	-	-	0.00 ± (0.00)	t	1.58 ± (0.65) ♀	sm	4.08 ± (0.42) ♀*	st	1.58 ± (0.07) ♀	sm
											2.15 ± (0.09) ♀	st	0.00 ± (0.00) ♀*	t	2.15 ± (0.09)	st
															1.48 ± (0.60) ♂	sm
El-Minia (19)	0.00 ± (0.00)	t	2.14 ± (0.07) ♀	st	5.76 ± (0.55) ♀*	st	2.14 ± (0.07) ♀	st	0.00 ± (0.00)	t	2.14 ± (0.07) ♀	st	4.25 ± (0.47) ♂*	st	1.78 ± (0.05) ♂	sm
	0.00 ± (0.00)	t	2.04 ± (0.07) ♂		0.00 ± (0.00) ♀*	t	2.04 ± (0.07) ♂	st			1.34 ± (0.30) ♀	sm	0.00 ± (0.00) ♂*	t		

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دراسات على الطرز المجموعى الكروموسومى لفأر النيل أو فأر الغيط *Arvicanthis niloticus* التابع لرتبة القوارض

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تهدف هذه الدراسة إلى التعرف على الأشكال المختلفة لطرز المجموعات الكروموسومية وكذلك كميات الهيتيروكروماتين الثابت التى تحتويها هذه الطرز المختلفة لفأر النيل أو فأر الغيط *Arvicanthis niloticus* وأيضا دراسة العلاقات التطورية داخل الجنس *Arvicanthis* . ولقد أظهرت نتائج الفحص السيتولوجى والتى تم أخذها على ٦٠ حيوان من أربع مناطق (المنيا – الفيوم – الشرقية – المنوفية) أن هذه الحيوانات جميعا لها عدد ثنائى متشابه وثابت هو ٦٢ كروموسوم ويبلغ عدد الأذرع الكروموسومية للكروموسومات الجسدية(aFN) = ٦٢ وأن جميع الكروموسومات الجسدية طرفية السنترومير (ماعداالكروموسوم رقم ٢٥ فهو وسطى السنترومير) وتحتوى على كميات كبيرة من الهيتيروكروماتين الثابت والموجود فى مناطق السنترومير وكذلك فإن بعض الكروموسومات كانت تحتوى على هيتيروكروماتين ثابت - وإن كان قليلا- فىمنطق طرفية أو بينية من الأذرع الكروموسومية وبالذات كروموسوم X .

وقد أظهرت القياسات المورفولوجية وجود إختلافات فى نسبة أطوال ذراعى كروموسوم رقم١ (يوجد منه السنترومير الطرفى والتحت طرفى) والتى جعلت العدد الأساسى للأذرع الكروموسومية يتغير ليصبح ٦٣ بدلا من ٦٢ فى بعض هذه الحيوانات من مناطق مختلفة فى مصر وكروموسوم X (يوجد منه التحت طرفى والتحت وسطى) وكذلك محتواهما من الهيتيروكروماتين الثابت (الذراع القصير لكروموسوم X كله مكون من الهيتيروكروماتين الثابت). وبناءا علي ذلك أمكن تقسيم الطرز الكروموسومية لهذا النوع إلى أربع طرز هى ANI-1[a], ANI-1[b], ANI-1[c], ANI-1[d] ناتجة ربما من حدوث نقص وزيادة للهيتيروكروماتين الثابت كنتيجة لحدوث إنقلابات شاملة للسنترومير.

وطبقا لهذه الدراسة فإن الطرز المجموعى الكروموسومى ANI-1[a] تعتبر الطرز الأساسى التى تشعبت منه باقى الطرز الثلاثة للنوع *Arvicanthis niloticus* فى مصر والذى أيضا يعتبر متشابها تماما مع ذلك النوع الأثيوبى والمسمى *A. dembeensis*, بغض النظر عن الإختلافات فى كروموسوم X .بينما تعتبر الطرز الكروموسومية الأخرى (ANI-1[b], ANI-1[c], ANI-1[d]) أقرب إلى الأنواع الأثيوبية *A. abyssinicus* و *A. blicki* . وبالتالى يمكن تلخيص أن جنس *Arvicanthis* يمكن أن يمثل بالأنواع المصرية الأثيوبية *A. niloticus*, '*A. dembeensis*', *A. abyssinicus* ,*A. blicki* و *A. centralis* وكذلك بالأنواع من أواسط غرب أفريقيا وهى *A. solatus* . وتجدر الإشارة إلى أن هذه الدراسة تفيد بأن *Arvicanthis niloticus* يمكن أن يكون مكون من عدة أنواع وليس نوع منفردا.