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The chromosomes of Planorbarius corneus (Linnaeus), with a discussion on the value of chromosome numbers in snail systematics [1])

by

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INTRODUCTION

The first accurate chromosome study on planorbid snails (Euthyneura: Basommatophora: Planorbidae) is that of LE CALVEZ & CERTAIN (1950) on *Planorbis* [= *Planorbarius*] *cornuta* [= *corneus*] [2]) and *Planorbis* [= *Anisus*] *vortex*. Both species were reported to have the haploid number (n) of 18. Since these authors found that other basommatophorans, namely *Physa acuta, P. fontinalis* (Physidae) and *Lymnaea limosa* (Lymnaeidae) also had haploid numbers of 18, they concluded that this was the basic haploid chromosome number (x) of basommatophoran snails. This early work was followed by further work on planorbids, i.e., that of INABA & TANAKA (1953) on *Gyraulus hiemantium* (n = 16), BONHAM (1955) on *Helisoma subcrenatum* (2 n = 36), and AZEVEDO & GONÇALVES (1956) on *Australorbis* [= *Planorbina*] *glabratus olivaceus* (n = 18) and *Planorbarius corneus* (n = 17). AZEVEDO & GONÇALVES were apparently unaware of the earlier investigations on *P. corneus* and the other planorbids. On the basis of the difference in chromosome numbers for the two species they studied, they concluded that chromosome numbers might be especially helpful in resolving the difficult systematic problems found in pulmonate gastropods. BURCH (1959, 1960a, b, c, d) studied

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[2]) Mrs. W. S. S. van der Feen-van Benthem Jutting has informed me that the species *cornuta* used by Le Calvez & Certain must certainly be *P. corneus* (Linnaeus), and that *cornuta* is an unfortunate misspelling.

eleven planorbid species (Table I) of which seven species had haploid numbers of 18, while one species had the haploid number 19, and three species had the haploid number 36 (x = 18).

TABLE I

Chromosome Numbers Reported in the Planorbidae *

Species	Haploid No.	Diploid No.	Investigator
Planorbinae			
Anisus vortex	18	—	Le Calvez & Certain, 1950
Armiger crista	18	—	Burch, 1960b
Gyraulus hiemantium	16	32	Inaba & Tanaka, 1953
G. deflectus	18	36	Burch, 1960a, b
G. circumstriatus	36 (x = 18)	72 ca.	Burch, 1960c
Helisoma anceps	18	36	Burch, 1960a, b
Helisoma subcrenatum	—	36	Bonham, 1955
H. trivolvis	18	36	Burch, 1960a, b
Planorbarius corneus	18	—	Le Calvez & Certain, 1950
Planorbina glabrata	18	36	Burch, 1960b, d
P. sudanica	18	36	Burch, 1960d
Planorbula crassilabris	19	—	Burch, 1960b
Promenetus exacuous	18	—	Burch, 1960b
Bulininae			
Bulinus truncatus	36 (x = 18)	72	Burch, 1960d
B. ugandae	36 (x = 18)	72 ca.	Burch, 1960d

* Unreliable reports are omitted.

It appears from the above that there are conflicting reports concerning the haploid chromosome number of *Planorbarius corneus*. It seems desirable to clear up this confusion, particularly when the chromosome number of *P. corneus* is used to justify cytological studies on freshwater mollusks.

MATERIALS AND METHODS

The snail species studied in this investigation was *Planorbarius corneus* (Linnaeus), collected in the Netherlands and generously supplied by Mrs. W. S. S. VAN DER FEEN-VAN BENTHEM JUTTING of the Zoölogisch Museum, Amsterdam. The material examined consisted of ovotestes from two specimens, both in active stages of gametogenesis. The tissues were killed, fixed and preserved in CARNOY's (1887) (acetic-ethanol-chloroform, 1:6:3 parts by volume) fluid and stained by the acetic-orcein squash technique (LA COUR, 1941). Observations were made with a Tiyoda microscope using a 90 × (n.a. 1.25) oil immersion objective and 10-30 × oculars. The chromosomes were drawn with the aid of a camera lucida and reproduced at a table-top magnification of 4650 ×.

OBSERVATIONS

Planorbarius corneus was found to have 18 bivalents present during late prophase and metaphase of the first meiotic division of spermatogenesis (Figs. 2, 3). The pairing behavior of the bivalents appeared normal, and during diakinesis the paired chromosomes were held together by one or more chiasmata. Thirty-six chromosomes were counted in spermatogonial cells. As seen in squash preparations, gonial metaphase chromosomes are monocentric, with mostly median or submedian primary constrictions (Fig. 1).

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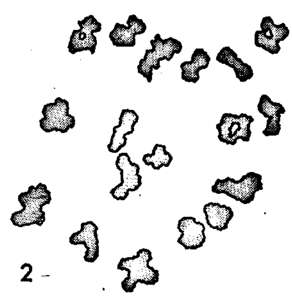

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Figs. 1-3. Camera lucida drawings of spermatogenesis chromosomes of *Planorbarius corneus* (× 1710). Fig. 1. Spermatogonial metaphase chromosomes. Fig. 2. Diakinesis chromosomes. Fig. 3. Metaphase I chromosomes.

DISCUSSION

The results of this investigation confirm the report of LE CALVEZ & CERTAIN (1950) concerning the chromosome number of *Planorbarius corneus.* My studies clearly show *P. corneus* from the Netherlands to have the haploid chromosome number of 18 and the diploid number of 36. It is possible, however, that the populations occurring in Portugal have lost a bivalent, and that the species there actually does have only 34 chromosomes. However, because of the many erroneous and unreliable chromosome reports of the past (cf. BURCH, 1960b) it would seem best to consider *P. corneus* to have only the haploid number of 18 until the report of AZEVEDO & CONÇALVES (1956) is confirmed.

From the above discussion it is evident that chromosome numbers are not satisfactory for distinguishing *Planorbarius corneus* from *Planorbina* [= *Australorbis*] *glabrata*. They will, however, separate *Gyraulus hiemantium* (n = 16), *G. deflectus* (n = 18) and *G. circumstriatus* (n = 36); they will distinguish *Planorbula crassilabris* (n = 19) from other planorbids; and they will separate perhaps all, but at least some, members of the subfamily Bulininae from the subfamily Planorbinae (except for *Gyraulus circumstriatus*) (Table I). But since 67% of planorbid species (Table I), and 72% of the basommatophoran species (Table II; Fig. 4) investigated so far have the haploid number 18, the chromosome number by itself has only very restricted value in species discrimination.

TABLE II

Chromosome Numbers Reported for Basommatophora *

Family	Haploid No.	No. of Species
ELLOBIIDAE	18	3
LYMNAEIDAE	17	4
	18	17
	19	1
PHYSIDAE	18	7
PLANORBIDAE	16	1
	18	10
	19	1
	36 (x = 18)	3
ANCYLIDAE	15	1
	17	1
	30	2
	60	1
ACROLOXIDAE	18	1

* From Bonham (1955), Burch (1960a, b, c, d; 1962), Burch, Basch & Bush (1960), Inaba & Tanaka (1953), Le Calvez & Certain (1950), and Perrot & Perrot, 1938. Many earlier reports are not listed because they are in error, or are not reliable (cf. Burch, 1960b).

Although chromosome numbers are of limited value at the level of the lower taxonomic categories, they can be used to advantage at higher systematic levels. The information which supports this reasoning is as follows:

1) Reliable work by various authors has shown that characteristically the chromosome numbers within various systematic categories in Euthyneuran snails tends to remain constant. The following exam-

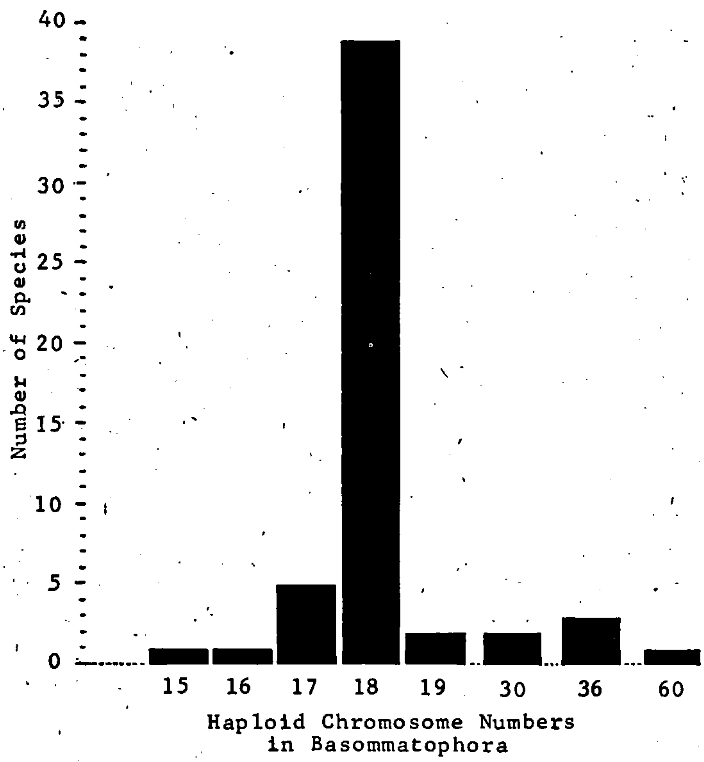

Fig. 4. This figure is a visual representation of the data in Table II.

ples illustrate this point: Subclass Opisthobranchiata: Order Nudibranchia, n = 13 for 13 species (INABA & HIROTA, 1958; INABA, 1959); Orders Anaspidea and Cephalaspidea, n = 17 for 4 species (INABA, 1959). Subclass Pulmonata: Order Basommatophora (minus Family Ancylidae), x = 18 for 41 species (BURCH, 1960a, b); Subfamily Ancylinae, x = 15 for 4 species (BURCH, BASCH & BUSH, 1960). Order Stylommatophora: Family Polygyridae, n = 29 for 15 species (HUSTED & BURCH, 1946); Genus *Agriolimax*, n = 30 for 3 species (BEESON, 1960); Genus *Limax*, n = 31 for 3 species (BEESON, 1960).

2) When one considers the chromosome numbers of the various euthyneuran groups in the light of their supposed evolutionary advancement (based on morphological considerations), it is evident that increased specialization has been accompanied by a tendency for increase in chromosome number. At the level of orders, for example, the various "opisthobranch" orders have haploid numbers of 17 or less, the Basommatophora, with rare exceptions, have the basic (x) haploid number of 18, and the Stylommatophora characteristically have haploid numbers of 20 or more. At lower levels within the Stylommatophora, higher chromosome numbers go with the more highly specialized species, lower numbers with less specialized species.

Therefore, when it is taken into account that chromosomal change in snails follows phylogenetic advancement with an increase in the direction of greater specialization, and that chromosome numbers in most systematic groups tend to be very stable, then one can see that slight but constant changes in basic chromosome numbers between systematic groups can be used as an indicator of primitiveness or specialization. It is at the higher levels that the chromosome numbers in snails are most useful in systematics.

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SUMMARY

1. The haploid chromosome number of the freshwater snail *Planorbarius corneus* from the Netherlands is 18, the diploid 36. The haploid number agrees with that found for this species in France by LE CALVEZ & CERTAIN (1950), but differs from the number (n = 17) reported by AZEVEDO & GONÇALVES (1956) for this species from Portugal.

2. Chromosome numbers have a very limited value for discriminating species in the euthyneuran gastropods, but can be used in regard to the higher taxonomic categories as an indicator of degree of specialization.

SAMENVATTING

1. Het haploide aantal chromosomen van de zoetwaterslak *Planorbarius corneus* uit Nederland is 18, het diploide 36. Dit haploide aantal komt overeen met het aantal, dat door LE CALVEZ & CERTAIN (1950) van dezelfde soort uit Frankrijk wordt aangegeven, maar verschilt van wat AZEVEDO & GONÇALVES (1956) over deze soort uit Portugal melden (n= 17).

2. Chromosomen-aantallen hebben voor het onderscheiden van soorten van euthyneure gastropoden slechts een zeer beperkte waarde, maar zij zijn bij hogere systematische categorieën bruikbaar als indicator van hun phylogenetische ontwikkelingsgraad.